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THE SYSTEM OF NATURE.

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THE

SYSTEM OF NATURE:

AN ESSAY.

BY

EDWARD NEWMAN, F.L.S., Z.S., &c.

SECOND EDITION.

LONDON:
JOHN VAN VOORST, PATERNOSTER ROW.
1843.

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"Experience once recognised as the fountain of all our knowledge of Nature, it follows that, in the study of nature and its laws, we ought at once to make up our minds to dismiss as idle prejudices, or at least suspend as premature, any preconceived notion of what might, or what ought to be, the order of Nature in any proposed case, and content ourselves with observing, as a plain matter of fact, what *is*." — *Herschell's Preliminary Discourse*, p. 79.

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TO

THADDEUS WILLIAM HARRIS, M.D.,

LIBRARIAN TO HARVARD UNIVERSITY,

I RESPECTFULLY DEDICATE

THIS HUMBLE ATTEMPT TO PORTRAY

THE PRINCIPLES

PERVADING

THE SYSTEM OF NATURE.

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PREFACE.

As this essay never before appeared under its present title, it seems necessary to explain why it is called a second edition.

In the year 1832 I published an essay under the title of 'Sphinx Vespiformis,' the object of which was to set forth the views now more fully explained.

The essay in question contained three chapters;— the first 'On the Primary Division of Nature;' the second 'On the Classes of Insecta;' and the third 'On the Sub-classes of Lepidoptera.'

The third chapter, treating solely of Lepidoptera, is entirely omitted in the present edition, and this for two reasons; — *first*, the subject seemed complete without that chapter; and *secondly*, my knowledge of Lepidoptera is not sufficiently extensive to enable me to elucidate my views by an analysis of that beautiful class. The insect whose situation formed a principal subject of the chapter in question, is not mentioned in the present edition, consequently its name, as a title, could not, with propriety, be retained.

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The first and second chapters, having been rewritten with considerable care, are now reprinted under a title appropriate to their object. In the course of preparing them for publication, they seemed to expand beyond the ordinary limits of chapters, and have therefore been further subdivided, making eleven instead of two. I trust this will be found a convenient arrangement.

The diagrams employed in the first edition, having reference exclusively to Entomology, are omitted. A map of the animal kingdom is added at the end. In this *man* is supposed the centre, and departure from his characters is expressed by a series of concentric circles.

London, March, 1843.

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CHAPTER I.

SYNTHETICAL GROUPING OF THE PLACENTAL ANIMALS.

ANY attempt to overthrow existing theories unanimously approved by men competent to decide on their merits — such for instance as Newton's of the planetary movements — should not only be made with the greatest caution, but received with the greatest distrust. We learn to consider such theories higher than the result of human ingenuity, and to regard the men who have revealed them as distinct from speculators, however skilful. But when, as in the arrangements of Natural History, there exists no general plan, each systematist enjoying the exclusive monopoly of his own views, it must be obvious that the *true* arrangement — the theory we can regard as greater than resulting from human ingenuity—is yet undiscovered. In a work on Astronomy, if the theory be not Newtonian it is nothing; but when a systematic work on Zoology makes its appearance, we immediately enquire "what is the arrangement?" We compare its merits with those of other arrangements; and so unusual a thing is it for an author to adopt the theory proposed by a prior author that such a proceeding would be held a matter of literary piracy: and should both authors have their works in the

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same market, this pirating an arrangement would be considered ample ground for an action at law. Thus it appears we all tacitly acknowledge that arrangement, so far as yet carried, is the result of human wisdom, judgment and inventive faculty, and neither has, nor is supposed to have, any reference to the designs of an omnipotent Creator. Those therefore who have looked on me with perhaps rather a jealous eye, as a competitor for reputation in the same field — the just classification of natural objects — have given themselves needless anxiety, from a mistaken idea of my views: our objects are not the same; our labours do not and cannot clash: *their* desire is by the application of human knowledge, and human skill and human industry, to build up a system that shall be permanent; *mine* to discover one already built, — a system in which human knowledge, skill and industry have had no part,—a system in fine whose Builder and Founder is the Almighty.

It has always appeared to me that the discovery of the natural system is the highest object of the naturalist: other branches of the science are collections of facts, the individual worth of which no one can doubt; but, like words, however fraught with meaning and sterling value, they acquire a meaning and value infinitely more extensive from the mode in which they may be arranged. I believe some writers contend that no fixed system or plan prevails in Nature, but that the similarity of one object to another is merely fortuitous, and forms no portion of an uniform design. To convince such as these I consider quite impossible: I would only suggest to them the great improbability that a Creator who has with such unerring wisdom adapted means to destined ends, should have performed any part of the mighty work of creation without a

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fixed and perfect design. When we consider that each muscle, tendon and vein in the animal frame occupies its appointed place, and has appointed functions, on the regular performance of which health and often life depend, it seems fair to infer that no created being exists without occupying also its appointed place, and performing its appointed functions in some perfectly organized system, however far such system may be above our finite and feeble understanding. To doubt the existence of such a system appears to me tantamount to doubting a creation; for one cannot suppose the various tribes of animals to have received their existence at the hands of an omnipotent Creator, and at the same time to be indebted to chance for those infinitely but harmoniously varied characters whereby we distinguish them.

It may be said that all schemes for the arrangement of animals place them following each other in a linear series: the line is generally supposed to be a direct one, but there are a few exceptions to this: the most striking alterations are those proposed by Lamarck, Goldfüss and MacLeay. Lamarck's linear series was double, the lines meeting in a point, and thus forming the letter V. MacLeay's series is curvilinear, the line "returning into itself:" the same may be said of that proposed by Goldfüss. Let us examine the best linear arrangement that human intellect has yet achieved. We find in the 'Règne Animal' the opossum placed next to the morse, the squirrel next to the wombat, the sloth next to the paca, the elephant next to the ornithorhynchus, the cow-whale next to the ox, the vulture next to the whale, the ostrich next to the pigeon, and many other proximities equally at variance with our own views; yet be it recollected we must not consider this as a series subject to our

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criticism: it is not the random arrangement of a careless author compiling by the page, neither is it the crude idea of a juvenile dabbler in natural history; it is the result of the most laborious dissection and analysis; it is the triumphant consummation of an almost superhuman intellect; and yet it contains abundant evidence of imperfection — of the imperfection of a system restricted by the formality of a line.

Infinitely varied though they be, the naturalist seldom finds in created beings those sudden transitions from one structure to another which this the most approved linear system is constantly exhibiting; the reason is obvious: in carefully following out similarities, in seeking with a free and unfettered mind to trace in each animal all its points of resemblance to others, he will constantly find some conspicuous form which shall possess several marked characters; one of such characters shall be possessed by several other animals, a different character by each different animal: again, he will often find that an obviously natural group contains widely different forms, some of such forms bearing a greater superficial resemblance to certain other groups than to the usual form of that group to which, from a comparison of their anatomical structure, they obviously belong: these forms, which have been called abnormal, differ also exceedingly from each other, yet still generally exhibit, in a nearly equal degree, though widely different mode, similarities to the usual or what is properly termed normal form of the group. Now no system hitherto invented will at all cope with this: in a linear series any group that shall contain representatives of even three other groups cannot possibly be so arranged as that each representative shall approach the form represented;

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hence no system possesses capacity sufficient to account for those diversified similarities which all reflecting naturalists must have observed, and I cannot but consider it the test of a natural system that structural similarity should be indicated by a corresponding propinquity in situation.

Those authors who have been most anxious to claim for themselves the invention of a natural system have always placed stumbling-blocks in their own way, by assigning peculiar virtues to favorite numbers or cabalistic figures; and when similarities of structure have occurred, too obvious to pass unnoticed, yet interfering with such numbers or figures, these have been dismissed under the title of relations of analogy. When this determination is once made the offending group is despatched to a distant part of the system. This clever idea saves an infinity of trouble, but it is subject to this little objection:—supposing an animal to possess three characters by which it is readily distinguished, a speculator may at all times refuse to notice either two of them, and insist on the validity of the third. As an instance, an insect may be arranged by its mouth, its wings, or its metamorphosis. Three of our modern systematists write about the relations of this insect. A, carefully examines its mouth, gives accurate figures of every part, compares these with similar parts in the mouth of other insects, and lays down the law as to its true relations. B, reads A's remarks almost with disgust; he sits down to reply, and he clearly proves in a paper of 20 pages, in some hot-pressed quarto, that A has mistaken a relation of analogy for one of affinity, and expresses his surprise and regret that a writer of the present day, and one too of acknowledged celebrity, should consult the mouth of an insect for relations of affinity, when the wings are so well known

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to afford the only true characters. C then comes into the field, and after a long diatribe on the want of knowledge shown by A and B, coolly asserts that from the metamorphosis alone true characters of affinity can be drawn. This is no caricature; it is an abuse to which relations of analogy must always be subject: every one can employ them to assist his own views, however far-fetched those views may be. For my own part I admit without hesitation the great and equal importance of all these characters, and I firmly believe that the slightest disposition to evade either of them, or, in fact, to evade or undervalue *any* structural or metamorphotic character, is in itself an evidence of *natural* incapacity to cope with the great question of *natural* arrangement. When an author tells me that he considers similarity of an insect's maxillæ, mesothorax, wings, or metamorphosis, to be only a relation of analogy, and not to indicate propinquity in a natural system, I feel satisfied that he is by *nature's* self precluded from ever becoming a revealer of her secrets. To no isolated character must be assigned a paramount importance, nor must such be dismissed as altogether valueless. Writers who think otherwise are unable to grapple with the subject; they voluntarily place their legs in the stocks and then think to contend in the race. All preconceived opinions disqualify the mind for an enquiry after truth; these must therefore be religiously avoided: the judgment must be perfectly unfettered: facts must be diligently collected and collated, and each well weighed, and its intrinsic value ascertained with the utmost precision.

To trace nature from the trivial differences which may distinguish two cognate species — differences often imperceptible to all but the instructed eye of the zoologist —

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upwards to the grand grouping of organized matter into kingdoms containing myriads of such species; to define accurately major and minor divisions; to assign to each division and to each individual its appropriate place in an enduring system; is a task in all probability far beyond the mental powers entrusted to us in this sublunary state of existence. Still may we not be allowed to pencil, with trembling hand, a dim and dubious outline? — to suggest whether there be not evidences of such and such designs? Believing that an attempt of this kind is not only allowable, but, if conducted in the right spirit, praiseworthy, I feel no hesitation in obtruding my views on the notice of naturalists, at the same time, should they prove correct, most distinctly disavowing any idea of merit; for if either of the combinations proposed be the result of human ingenuity, it can form no portion of that system of creation called into being by the fiat of Omnipotence.

My first idea on this subject, confirmed and supported by each new fact that comes to my knowledge, may be thus defined: — Every animal or group of animals being structurally similar in an equal degree to several other animals or groups of animals, such similarity in one to several can only be expressed by so approximating all, that each shall approach its like. As a familiar illustration of my meaning, I adduce the four marked groups of vertebrated animals; 1. placental viviparous animals; 2. birds; 3. reptiles; 4. fishes: no naturalist of any standing will question the propriety — in fine the truth of these divisions: I do not say that no naturalist will plead the existence of other groups which may be placed on an equal footing with these, but that none will attempt to maintain that these are not signally natural

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and signally distinct. In one of these groups — the placental animals — we find a bat, an ant-eater, and a dolphin, and these respectively structurally resemble a bird, a reptile, and a fish. It appears to me that this structural resemblance can only be shown by placing the placental animals in the centre, and the others around them.

From this principle of approximating like to like certain seemingly cabalistic numbers or figures may perchance result, but a long and careful consideration of this branch of the enquiry has thoroughly convinced me that such numbers and figures are the *result* of a principle, and *not* the principle itself. But another result is deducible from this besides the position of the three exterior groups. Bats, ant-eaters and dolphins, though truly placental, viviparous and mammalious animals, are extreme or abnormal forms: the normal forms—those animals emphatically called quadrupeds—must be placed *within* these; and so we are induced to adopt a belief in the existence of normal superior centres throughout the animal kingdom. I am willing to confess the difficulty there is in finding these normal centres, and the great uncertainty which must prevail as to what characters shall intimate such normal and central superiority; nor in my fondest anticipations for the reception of this system, do I ever picture to myself the pleasure of seeing the point definitively settled in more than a very few instances.

In looking for a centre around which to arrange the almost infinite hosts of the animal kingdom, vanity may perhaps induce man to select himself; yet, whatever the motive in making it, this choice is apparently sanctioned by reason and research, for all the observations of our comparative anatomists tend to show the propriety as well

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as convenience of considering the human frame a model, the departures from which, manifested in the diversified forms of animals, afford characters of distinction: still this rigid comparison of analogous parts does not hold good beyond certain limits, as in the abnormal or distal groups each individual appears to draw its more obvious characters from some nearer model. The great superiority of man consists not, however, in general structure; the ascendancy he has gained over other animals, — a great evidence of superiority, — is one of intellect only, and the result of the quantity and structure of his brain: "no quadruped approaches him in the magnitude and convolutions of the hemispheres of the brain: he is the only example of his genus, or even order:"— C. R. A.*—he is, by his superior intelligence, the monarch of the animal kingdom. Placed therefore in the centre, he is of necessity approached by the various families of monkeys, &c., the structural similarity of which to the model frame of man is often striking. "Their intestines are very similar to those of man; like him also they have eyes directed forward, and mammæ placed on the chest." — C. R. A. But the most important point of similarity, because an approach to that peculiar intelligence which places man on the throne of the animal kingdom, appears to be in the brain, which has "three lobes on each side, the posterior of which covers the cerebellum, and the temporal fossa is separated from the orbit by a bony par-

* Cuvier's 'Règne Animal.' I have invariably preferred availing myself of observations contained in works of acknowledged authority, when such observations express my own views, the passages which I think particularly striking being printed in italics.

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tition." — C. R. A. A second group, equivalent to the monkeys, is found in the lemurs; and I am unable to resist the conviction that a third group, always held to be one of great inferiority, occupies a place corresponding with that of the monkeys and lemurs. It will be seen that I allude to the sloths; and I am fully aware how much I hazard in venturing thus to break up the group known as Edentata, more especially since I purpose reducing it still further by the abstraction of the monotrematous marsupials.

Having proposed an alteration so important as the removal of the sloth from the Bruta to the Primates, I must explain my reasons for doing so. The face of the sloth is round, short, and remarkable for its almost human expression, a character even more observable in this animal than in the majority of the monkeys. The structure of the skull and the teeth also exhibit some approaches to the monkeys, but none to the ant-eaters. The size, figure, and general external appearance is that of a monkey. The mammæ are two only, and these are pectoral. The feet are always used as hands for grasping and climbing, and *never* as feet for walking or running on the ground. The sloth spends his time entirely in trees, among the branches of which he travels with wonderful rapidity. Having thus shown a series of approaches to the Primates, some of them perhaps rather superficial, but others really structural, I am willing to admit that there are other characters which seem to give the sloth a station in the system far below that of the monkeys. These are the inability to make progressive movement on the earth, the structure of the brain, and that of the arteries of the limbs. These must be examined separately. 1st. The inability to walk or run on the

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earth: this is evidently the result of structure. "The hind feet are articulated obliquely to the shank, and rest on their outer edge only."—C. R. A. "The arms are much longer than the legs," — C. R. A. — "and the pelvis is so large, and the thighs so much inclined to the sides, that the knees cannot be approximated."—C. R. A. If we compare the sloth as regards this resting on the outer edge of the foot only, and consequent difficulty of walking, this elongation of the arms and spreading of the knees, with the orang-otan, which is generally considered one of the most perfect monkeys, we cannot fail to observe a very striking similarity. The almost entire want of a tail, and the peculiar disposition of both the sloth and orang-otan to climb in a pendant position, with the back downwards, are also obvious points of similarity between these animals. 2ndly. With regard to the brain: if its character be correctly stated as regards the sloth, there appears a great and irreconcileable difference. 3rdly. The structure of the arteries: it has been found by M. Carlisle "that the arteries of the limbs commence by splitting into an infinity of ramifications, which afterwards unite in one trunk, from which the usual branches proceed."— C. R. A. This certainly would seem an almost insuperable objection to placing the sloth in the situation now proposed, were we not aware that "M. Carlisle found at the base of the arteries of the limbs [in the loris or sloth-monkeys] the same ramifications as in the true sloths."—C. R. A. A similar length of arms, awkwardness of gait, and want of tail, characterize both groups. The three groups thus briefly indicated, — the monkeys, lemurs and sloths, — together with man, their model and type, I suppose to constitute a superior group, somewhat corresponding to the Primates of Linneus: the

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normal character of man placing him in the centre, the other groups surround him: the relative position of these, although doubtless fixed, is immaterial to my present purpose. Sloths, if structurally similar to either, are equally so to both: their station, therefore, may be given provisionally as under:—

Simia. Lemur.

Homo.

Bradypus.

The names of genera are here introduced as expressing the groups to which those genera belong. I wish it to be most distinctly understood that the restricted genera, Simia, Lemur and Bradypus, are not intended to be placed in contact with the surrounding groups. Simia in particular recedes from the Feræ rather than approaches them.

It now becomes necessary to examine the remaining groups of placental animals, and if we consider Primates to be the normal group, I think we shall find it convenient to divide the remainder into three subnormal and three abnormal groups, the subnormal groups forming a tolerably complete series among themselves, but the abnormal groups being apparently less connected with each other. The subnormal groups are the Feræ, Glires and Belluæ; and the abnormal groups the Cheiroptera or bats, Bruta or ant-eaters, and Cete or whales, each of the latter departing widely from the structure of the Primates, and becoming as it were placental birds, placental reptiles and

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placental fishes: the subnormal and abnormal groups appear to alternate with each other in this manner,—Feræ, Cheiroptera, Glires, Bruta, Belluæ, Cete, and the relative mutual similarities of the seven groups may be shown thus:—

CHEIROPTERA.

FERÆ. GLIRES.

PRIMATES.

CETE. BELLUÆ. BRUTA.

The more decided structural similarities existing among the animals composing these seven groups are to be sought between the Primates, Feræ, Glires and Belluæ, the abnormal groups of Cheiroptera, Bruta and Cete, being regarded as links connecting the placental with implacental or oviparous groups, rather than groups essential to the integrity of the placentals. I will therefore endeavour to point out on what grounds I have imagined a connexion between the normal and the subnormal placentals.

Beginning with the Feræ, (in which group I need scarcely say that I include the Sorecidæ or Insectivora of authors), we shall find these and the monkeys manifestly approach each other in many points, more especially in the teeth, shape of the head, and intellectual capacity.

Passing to the lemurs, we come to the Cheiromys psylodactylus or Aye-Aye of Madagascar. Should this strange animal, combining as it does the dentition of the Glires with the opposable thumb peculiar to the monkeys, be hereafter proved to belong to the Glires instead of the Primates, as many authors, including Cuvier, have

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supposed, then Tarsius, Galago and other genera instantly fill up the gap, and make the connexion between the Primates and Glires equally natural; thus this anomalous and intermediate form, which has caused so much discussion among the scientific, serves to show the unity of design manifested in Nature's system. From Cheiromys we pass through the other lemurs to L. tardigradus, whose slothful gait " has caused some authors to assert, in opposition to Buffon and to truth, that the genus of sloths exists also in Asia."—C. R. A.

We thus return to that singular and apparently isolated being the sloth: I say *apparently*, for I think not *really* isolated. I have already endeavoured to show his coincidence in many characters with the sloth-monkey and orang-otan, and have placed him between them, freely admitting that the approach to either is not very close,—indeed had it been so it would have become a much more difficult task to show an unity and uniformity in system than it at present appears. A third, and very unexpected approach to a widely different group of animals, is also exhibited in the sloth: it has four stomachs, or rather a quadruple stomach, precisely analogous to that of the ruminants: this fact, together with a second, namely, the union of its fingers and toes, and the investment of their extremities with great claws almost amounting to hoofs, are further and undeniable evidences of this approach: thus we find this singular animal manifesting approaches to three groups,—the monkeys, the lemurs and the Belluæ.

In connexion with this supposed approach of the sloths to the Belluæ, it seems desirable to make some allusion to those gigantic creatures once possessed of a destructive power over living vegetables, compared with which

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that of the recent sloth sinks into insignificance. Ranging through the antediluvian forests of South America, were sloth-like forms very similar in structure to those now existtent, but endowed with such ponderous bulk and strength that the rhinoceros and hippopotamus were evidently their inferiors: no living quadruped possesses muscular power equal to that indicated by the fossil bones of the Megatherium. The gigantic vegetables of antediluvian forests must have been crushed and rent in pieces to afford him a single meal. The fertile imagination of our geologists, with a view to the more complete consolidation of the group Edentata, has clothed this monster with an imaginary suit of armour, thus giving him the osteology of the sloth and the carapax of the armadillo; but of this there is not sufficient evidence, the dorsal vertebræ wanting those peculiar lateral processes so essential to the support of a weighty osseous carapax. I should rather fancy him a sloth in all his characters, with a round monkey-like face, an awkward gait, shaggy hair, pectoral mammæ, &c. Megalonyx, Milodon, and (if distinct) Dr. Harlan's Orycterotherium Missouriense, evidently approach Megatherium, and unite in forming a group of animals which, though now extinct, must formerly have played a conspicuous part on the earth's surface, ere man was allowed to become the monarch of terrestrial beings. Inconsistent as it may appear to suppose any approach from the little monkey-like sloth to the giant elephant, these almost equally giant Megatheria will render the connexion more probable. The remarkable character of pectoral mammæ possessed by the elephant in common with the sloth, is another evidence of approach, and the similarity of their food forms still another bond of union between the three superficially

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dissimilar tribes: all appear to have fed exclusively on vegetables: the sloth ran along the boughs, devouring the leaves around him: the Megatherium was endowed with strength to uproot the giants of the forest with his tremendous claws, and he doubtless delighted in the crashing ruin: the elephant, by means of his extraordinary and singularly extensible trunk, drew down the branches, snapped them off, and, keeping them steady on the ground by the weight of his ponderous foot, stripped them of their verdure.

The divisions of Belluæ appear to require much consideration, and I scarcely feel inclined to subscribe to those in common use. Although unwilling to dissent from the views of Cuvier, I must confess that some of his combinations of those animals with which I am acquainted, as Hippopotamus with Sus, appear to be rather questionable: again, his separation of Sus from Anoplotherium seems scarcely natural. The Linnean idea of separating the ruminants from the other Belluæ, although adopted by Cuvier, seems to me very objectionable, more especially as this illustrious naturalist has himself, in his 'Ossemens Fossiles,' so clearly pointed out their extreme similarity. His opinions on this interesting subject, as enforced by Professor Owen in a recent number of the Athenæum, are so exactly in accordance with my own views that I shall quote them at length. "Cuvier says of the teeth of the Anoplotherium gracile, that they present a structure which closely approximates them to their analogues in the ruminants (Ossemens Fossiles, 4to. t. iii. p. 61): of the molar teeth in the smaller Anoplotheres, constituting the subgenus Dichobune, Cuvier observes, that 'they still more nearly approach the molars of the ruminants,' (loc. cit. p. 63): he describes the interval between the molars

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and incisors in this subgenus, and of the latter teeth he affirms that they are entirely similar to those of ruminants. Cuvier concludes his description of the teeth and jaws of these ruminant-like Anoplotheria by the following emphatic statement,—'Or, cette dentition, cette forme de branche montante, cette grandeur même, resemblent prodigieusement à ce qu'on observe dans les jeunes chevrotains.'—(loc. cit. p. 65.)"

The abnormal placentals now require a brief notice; and although I am far from being inclined to insist on the existence of a very decided connexion between groups supposed to form a circle, yet I think, from a perusal of the observations immediately following, it will appear that there exists a degree of completeness and unity in the relative position of the six groups containing the subnormal and abnormal placentals,—a completeness and unity that would be equally destroyed by the intervention of the Primates at any point of the circle, as by the transposition, in any instance, of a subnormal and abnormal group. Moreover, several striking departures from normal structure, observable in the abnormal groups, and now abundantly accounted for by their proximity to the Primates, would, by the removal of that group from the centre, appear nothing better than capricious deviations from uniformity of design.

1st. *The Cheiroptera, ornithoid placentals, or bats.* In this group I am inclined to place the remarkable genus Galeopithecus, not merely because Cuvier has thus decided, but because its structure, combined with its nocturnal habits and insect food, appear quite in favor of his decision. It is said, when at rest, to hang by its hinder claws, with its head downwards. The genus Pteropus, comprising the

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vampyre bats, closely resembles some of the insectivorous Feræ. Galeopithecus approaches the Primates, and the similarity of Vespertilio pipistrellus, and other of the smaller bats, to the mice among the Glires is very obvious. It is perhaps no proof of these structural resemblances that they are so generally admitted, yet this must be my excuse for passing them over with so slight a notice.

2ndly. *The Bruta or herpetoid placentals.* Among these Myrmecophaga didactyla, a little climbing animal about the size of a rat, and furnished with a prehensile tail, approaches some of the lemurs and the sloths; and the armadilloes, either with or without the intervention of Megatherium, &c., are considered by all zoologists to approach the Belluæ: among the Glires, some of the climbing porcupines, with long and prehensile tails and great claws, certainly approach the climbing ant-eaters.

3rdly. *The Cete or ichthyoid placentals.* With regard to the contents of this group, I must confess that I feel inclined to dissent from the views of Linneus, Cuvier, and all the more eminent zoologists. It has long seemed to me that sufficient attention has never been paid to uniformity of plan in the characters assigned to divisions, and if I repeat this somewhat frequently, and insist on it somewhat strenuously, it is because I am deeply impressed with its importance. Now if we regard the aquatic birds as a good and natural group, why not, on the very same principle, collect the aquatic Mammalia. Why should the seal (and more especially the walrus, living wholly on sea-weed) be associated with the lions and tigers, when the sea-gull is not associated with the eagles? No naturalist can regard for a moment the bulky walrus, either as to its habit, its food, its ivory tusks, or its general osteology, and pre-

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sume to point out its similarity to the beasts of prey. There may be reason in hesitating whether it associate more naturally with the Belluæ or the whales, but its sole connexion with the beasts of prey is to be found in fictitious figures, which give it a fancied resemblance to the seal. Now if we associate into one group all the marine Mammalia, as we do the aquatic birds, we shall find it much more easy to reconcile the differences in their structure. The station supposed to be occupied by this group approximates it to four others, — Feræ, Primates, Belluæ, and the true fishes, — thus :—

FERÆ.

A PRIMATES.

B

CETE. C BELLUÆ.

D

PISCES.

At A I would place the seals : the walrus, though certainly constituting a distinct family, perhaps belongs to the same primary division of Cete, and as both have been so long associated with the Feræ, I need say nothing to enforce this view : at B I think the Manatidæ will be naturally located. "They have two mammæ on the chest, and mustachio-like hairs [on the upper lip] ; two circumstances which when observed from a distance, as they raise the anterior part vertically above the water, may give them some resemblance to man or woman, and hence have probably arisen those fabulous accounts of Tritons and Sirens which some travellers pretend to

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have seen: * * vestiges of nails are discoverable on the edges of their fins, which they employ with tolerable dexterity in creeping and in *carrying their young;* hence the comparison of these organs with hands, and the name of Manatus applied to these animals."—C. R. A. And here I do not hesitate to avow my belief that there are animals contained in this group of marine placentals which much more nearly approach the Primates than any of those contained in our museums or catalogues. The following description from Shaw's Zoology is certainly that of an animal of which we have but little authentic knowledge:—"This species (the sea-ape Manati) is only known from the description of Steller, who, near the coast of America, saw a singular animal which he chose to name a *sea-ape.* It was about five feet long, with a head like a dog's; the ears sharp and erect, and the eyes large; on both lips it had a kind of beard; the form of the body was thick and round, but tapering to the tail, which was bifurcated, with the upper lobe longest; the body was covered with thick hair, grey on the back and red on the belly. Steller could not discover any feet or paws. It was full of frolic, and sported in the manner of a monkey, swimming sometimes on one side of the ship and sometimes on the other, and looking at it with much seeming surprise. It would come so near the ship that it might be touched with a pole, but if any one stirred it would immediately retire. It often raised one-third of its body above water, and stood upright for a considerable time; then suddenly darted under the ship, and appeared in the same attitude on the other side: this it would repeat for thirty times together. It would frequently bring up a sea plant not unlike a bottle-gourd, which it would toss about and catch again in its

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mouth, playing numberless fantastic tricks with it."* In Captain Weddell's Voyage we also find an apparently authentic narrative of the discovery, on the South Shetland Islands, of another marine animal, entirely different from any with which we are acquainted. "A boat's crew were employed" says Captain Weddell, "on Hall Island, and the man who saw this animal was left on one side of the island to take care of some produce, while the officers and the rest of the crew were engaged on the other side. The sailor had gone to bed, and about 10 o'clock he heard a noise resembling human cries, and as daylight in these latitudes never disappears at this season, he rose and looked around, but on seeing no person he returned to bed; presently he heard the noise again, and rose a second time, but still saw nothing. Conceiving however the possibility of a boat being upset, and that some of the crew might be clinging to some detached rocks, he walked along the beach a few steps, and heard the noise more distinctly, but in a musical strain. On searching around he saw an object lying on a rock a dozen yards from the shore, at which he was somewhat frightened. The face and shoulders appeared of human form, and of a reddish colour; over the shoulders hung long green hair; the tail resembled that of the seal, but the extremities of the arms he could not see distinctly. The creature continued to make a musical noise while he gazed about two minutes, and on perceiving him it disappeared in an instant. Immediately when the man saw his officer he told this wild tale, the truth of which was, of course, doubted; but to add weight to his testimony (being a catholic) he made a

* Shaw's General Zoology.

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cross on the sand, which he kissed in form of making oath to the truth of his statement. When the story was told me I ridiculed it, but by way of diversion I sent for the sailor who saw this nondescript, into the cabin, and questioned him respecting it. He told me the story as I have related it, and in so clear and positive a manner, making oath as to its truth, that I concluded he must really have seen the animal he described, or that it must have been the effects of a disturbed imagination."* In neither of these seemingly authentic statements is any allusion made to arms, the constant and important appendages of the fabulous mermaid, and certainly not to be omitted in a fictitious narrative; indeed had I amused myself with describing animals, such as I could wish to find, really belonging to the Cete yet closely approximating to the Primates, I could not have accomplished this in so satisfactory a manner as these authors have done, although they never dreamed of the purpose for which their descriptions would be quoted.

To return to the diagram at page 19: the seals being placed at A, the walrus possibly intervenes between these and Manatus, which is our nearest approach to the Primates; for much nearer as Halicore and Rytina would at first appear, their dentition is widely different, Rytina having but a single molar tooth on each side above and below: this is of oblong shape, very large size, and said to be flat and wrinkled on the crown, with many zigzag ridges of enamel; but the intermediate spaces which form the substance of the tooth are of a horny nature. These

* A Voyage towards the South Pole, 1822-24, by James Weddell, Esq., Master in the Royal Navy.—p. 142.

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molars have no true roots, but are united to the jaw-bones by means of cartilage. It is truly remarkable, that although the Northern Seas appear to be teeming with this strange animal, it does not exist in any of our museums, and a most profound ignorance seems to prevail respecting it. Even Swainson, a zoologist of distinction, states it is from the South Seas, an assertion which the narrations of voyagers do not bear out. This animal appears intermediate between the normal whales and the Halicoridæ, of which group the Indian dugong is the only known living representative. There is, however, an extinct animal, — the Dinotherium,—which, from the structure of its molar teeth, has been supposed a tapir: this I think will eventually be found, when we attain a more precise knowledge of its skeleton, to be intermediate between the dugong and the Belluæ. This huge animal was eighteen or twenty feet in length: its scapula was like that of the mole; whence Mantell and other authors argue that its fore-feet were formed for digging: but its chief distinction from all existent animals was in the enormous curved ivory tusks, equalling the elephant's in size, and resembling those of the walrus in curvature, but by a strange anomaly placed in the lower instead of the upper jaw. Until further knowledge is obtained of the Dinotherium, we must consider that it approaches both the tapirs and the dugongs, the latter group certainly occupying a natural position at C, intermediate between the true whales and the Belluæ, the former being supposed the normal and central group of Cete, while the dolphins, situated at D, lead to the true fishes. It cannot be said that my object in uniting the seals and walruses to the marine Mammalia is the support of my own views of natural arrangement, for in

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the present day of rigid enquiry nothing is taken for granted; and the anatomist who proves my view of the seal and walrus to be unsound, must place one with the Feræ and the other with the Belluæ, and each at the point where these groups approach the Cete, — an arrangement peculiarly corroborative of the entirety and unity of the system I am attempting to explain.

Far from insisting on this arrangement of the marine placentals, or on any of the approaches now proposed as natural, I rather offer them for consideration: supposing them fallacious, — still fallacies in such minor points cannot shake the fabric. No one thinks of denying the beauty and unity of design in a building because a stone has here and there fallen from its place. The fallen stones are replaced by others, and the building is more stable than before. If my suggestion of excluding Galeopithecus from the Primates, prove unsound, then it may enter that group and form an abnormal division. Again, if Bradypus will not lead to the Belluæ, it may probably, in accordance with the views of Cuvier and others, approach the Bruta. Myrmecophaga didactyla I have already said approaches the Primates, and the great ant-eater treads on the side of its foot exactly like the sloth, although perhaps for a different purpose, — to preserve its huge claws from wearing at the points, which would in a great measure prevent their performing the duty for which they were designed, that of scratching the ant-hills.

Again, authors of high and deserved reputation have considered one group of monkeys infinitely superior to the rest. This comprises the genera Macacus, Papio and Simia, each considerably subdivided, and now forming small groups to which the title of families has been ap-

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plied. Now supposing it to be clearly established, that these anthropoid monkeys or apes are structurally more similar to man than the American monkeys, the lemurs or the sloths,—is it not possible that they may constitute, together with man, the central and normal group of all animals? It is not inconsistent with the views now defined to suppose a central and normal group of Primates, containing one normal and three abnormal forms. Man would of course be the centre, the "heart's core." Some of the true Simiæ would lead to Bradypus; Macacus to Cebus; Papio to Lemur. Carrying the same idea still farther,—is not man himself divisible into four groups? May we not place the Circassian in the centre, while the African approached Simia and Bradypus,—the Asiatic, Papio and Lemur,—the American, Macacus and Cebus? Those who take an interest in following out these analogies could scarcely fail of tracing some indications of the approaches here suggested. They might perchance find the wild, nocturnal, shrewd, daring, whooping, untiring Red Indian represented by the Cebidæ. The slow, feeble, heavy-lipped, patient, toil-enduring Negro in the chimpanzee. The sly, greedy, lecherous, vindictive and cruel Mongolian or Malay in the baboon. This is avowedly suggested only as hypothetical, but it may perhaps lead some truth-seeking naturalist to pursue the enquiry.

This position of the true Simiæ around the central and normal form of man, would make the Cebidæ an abnormal group approaching the Feræ, a position certainly indicated by their enormous canine teeth: the transition from Papio and Inuus to the lemurs appears easy and natural; and that from Simia or Pithecus to the sloths is, I think, perfectly obvious. It thus appears, that if driven from the

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ternary division of abnormal Primates, into monkeys, lemurs and sloths, an arrangement of these groups yet remains perfectly natural; and it seems to me a matter of certainty that a skilful naturalist, by disproving my original position, compels me to adopt one which I was fearful of suggesting, lest it should be considered hypothetical, but one which still more fully carries out my original view of natural arrangement.

I have already said that the subnormal groups of the placental animals form of themselves a series tolerably complete: perhaps this will be more clearly understood by citing the genera which have led me to this conclusion. In the Glires, Spalax seems to approach the insectivorous Feræ, more especially the mole: in the Feræ, the bear tribe approach the Belluæ: and in the Belluæ, Hyrax approaches the Glires so closely that its real connection with the rhinoceros is overlooked by all but scientific naturalists. This little animal is the daman, Syrian rabbit, Cape rabbit, rock rabbit, &c., of travellers, and is the coney of Scripture. Until Cuvier correctly described its structure no one supposed its connexion with the rhinoceros.

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CHAPTER II.

THE MARSUPIAL ANIMALS A DISTINCT CLASS.

In commencing the next branch of the enquiry, namely, by what abnormal vertebrate groups are the placental animals surrounded? I should say, in the first place, that the marsupials form a class, distinguished from the placentals by their physiology, their divisibility, and their antiquity.

1st. *Their Physiology.* The marsupials differ from the placental animals in a number of peculiarities so remarkable that it seems astonishing that naturalists have until lately passed them over without a notice. "The first of all these peculiarities is the premature production of their young, which are born in a state of development scarcely comparable to that of an ordinary fœtus a few days after conception. Incapable of motion and hardly exhibiting the germs of limbs and other external organs, these little ones attach themselves to the mammæ of the mother, and there remain fixed until they acquire the degree of development in which animals are usually born."—C. R. A. The young of a kangaroo examined by Professor Owen twelve hours after birth "resembled an earth worm in the colour and semitransparency of its integument, adhered firmly to the point of the nipple, breathed strongly

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but slowly, and moved its fore-legs when disturbed. Its body was bent upon the abdomen, its short tail tucked in between the hind legs, which were one-third shorter than the fore legs, but with the three divisions of the toes now distinct. The whole length from the nose to the end of the tail, when stretched out, did not exceed 1 inch 2 lines."* In the adult animal "the skin of the abdomen is almost always so arranged about the mammæ as to form a pouch, and in this these imperfect little animals are preserved as in a second uterus;"—C. R. A.—and "closely connected with the pouch and with the generation of the animals of the present group are the marsupial bones which so peculiarly characterize it. These bones are even more constant than the pouch, being found in the Echidna and Ornithorhynchus, in which no traces of a pouch have been discovered. They are elongated and flattened, widely separated at their distal extremity, and converge as they approach the pubis, to which they are joined."† These "marsupial bones, so common in the skeletons of reptiles, are limited in the mammiferous class to this division, in which alone, from the peculiarly brief period of uterine gestation and the consequent non-enlargement of the abdomen, their presence might be expected."‡ In the formation of the sexual organs both sexes present a marked difference from that observed in the placental series: in this family "the uterus does not open by a single orifice into the extreme end of the vagina, but communicates with this canal by two lateral tubes resembling handles," and "the scrotum of the male, contrary to what obtains in other quadrupeds,

* Owen, Phil. Trans. part ii. for 1834.

† Waterhouse, Mar. 67. ‡ Owen, Phil. Trans. 1834, p. 333.

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hangs before the penis, which when at rest is directed backwards."—C. R. A. "Both sexes manifest their affinity to the oviparous classes in possessing two superior *venæ cavæ*, and in the want of the inferior mesenteric artery." * Still more important even than these discrepancies in the organs of generation and circulation are those of the brain. "We can trace through the different orders the increasing complication of this organ, until we find it in man to have attained that condition which so eminently distinguishes him from the rest of the class. And if the introduction of new powers into an organism necessarily requires a modification in its mode of development, with what other than the perfection of the nervous system can we connect true viviparous or placental generation? for we do not perceive that in their digestion, circulation, respiration, locomotion or temperature, the mammiferous Vertebrata are in any degree advanced beyond the bird, in consequence of their more complex, or, as it may be termed, more careful generation."† "Agreeably to this view, connected with the ovo-viviparous generation of the Marsupiata, and with an inferiority of intelligence which Professor Owen observed in these animals when in confinement, he was induced to undertake a careful examination of the brain in the various marsupial animals, and the result of this investigation was a most interesting discovery. Besides the decreased size of the hemispheres of the brain, and consequent exposure of the cerebellum, indicative of a low grade of organization, the *corpus callosum* and *septum lucidum* were found to be entirely wanting in these

* Owen, Phil. Trans. 1834, p. 333.

† Owen, Phil. Trans. 1834, p. 359.

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animals, or at least existing only in a rudimentary state. Now the *corpus callosum*, which is the principal bond of union between the opposite hemispheres of the brain, had been regarded as the great characteristic of the brain in the Mammalia, and in fact this commissural apparatus presents the essential difference which exists between that and the oviparous vertebrate classes."* When to so important a modification of the cerebral organ as the absence of the *corpus callosum* and *septum lucidum*, "are added the traces of the oviparous type of structure presented in the circulating and absorbent systems, together with the peculiarities of the osseous and generative apparatus, we may with reason suspect that distribution of the Marsupiata to be artificial, and founded on an imperfect knowledge of their mutual affinities, which from a modification of the teeth and extremities alone would separate and disperse the species amongst corresponding groups of the placental Mammalia."†

Mr. Ogilby, the talented secretary of the Zoological Society, has published some papers on the marsupial animals in the 'Magazine of Natural History.' In the course of his remarks he has alluded to the observations of Meckel on the discovery of mammary glands in the female Ornithorhynchus, and adds in a foot note, "The observations of Meckel have been fully and most satisfactorily confirmed, since this passage was written, by the investigations of Mr. Owen; *and it is now definitely established that these singular and anomalous animals, not only lay eggs and hatch them like birds, but likewise support their young, when excluded from the shell, by means of a thick milky fluid*, which at that period exudes copiously from

* Waterh. Mars. 69. † Owen, Phil. Trans. part i. 1837.

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the glands observed by these able anatomists."* The same author cites the opinions of Professor Agardh, as published at p. 453 of a work entitled 'Allman Wext Biologi af C. A. Agardh.' I shall make no apology for transferring the entire passage to my pages, as it appears so confirmatory of my views. The cord spoken of as resembling a navel-string may probably admit of another explanation, but concerning this, and the transfer of the young from the first to the second uterus, much still remains to be learned. The passage from Agardh is as follows: — "The marsupials are Mammalia which approach very nearly to birds; the Monotremata in particular almost coincide with them. Not only do the developed form of the hind legs, the deranged functions of the anterior extremities, the position of the body, and the destination of the tail to govern the pace, all indicate this affinity, but their internal structure is likewise very similar. They constitute a distinct group of Mammalia, combining carnivorous as well as herbivorous animals, in the same manner as birds contain predacious as well as frugivorous tribes. They have no distinct internal uterus, for it is only the connection of the two oviducts to which that name has hitherto been given; neither have they a peculiar vagina, for the organ which Daubenton and Geoffroy thus distinguish, when they assert that the marsupials have two vaginæ, belongs rather, according to the researches of Tyson, to the oviducts or Fallopian tubes; so that, except in the doubleness of the parts, *the marsupials resemble birds in their organs of generation, as well as in other respects.* The embryo also is brought forth, not as in other Mammalia, perfectly formed, but it is produced in the state of an egg, and in that form

* Mag. Nat. Hist. N. S. iii. 345.

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deposited in the marsupium or uterus. Now the egg or embryo of the Mammalia has the property of attaching itself to every part of the uterus at the point where the placenta is formed; and thus the embryo or egg of the marsupials fastens itself to the mamma, and there communicates with the arteria epigastrica, in the same manner as in other Mammalia it communicates with the arteria uterina. It is fastened by a cord resembling the navel-string, (though it is unknown where this cord passes out from the embryo), which is often so long that the embryo hangs out of the bag, and which, at the moment of real birth, is separated by a rupture, as in the case of the placenta and ordinary uterus. This external uterus, however, does not invariably assume the form of a purse or bag; in some instances it consists of simple folds of the skin, and in the monotremes even these disappear.

"The monotremes bear a very strong affinity to the ordinary marsupials: *they likewise very closely resemble birds, not alone in the construction of the bill, cranium, clavicles, shoulder-bones, sternum, and undeveloped teats, but especially in their organs of generation.* These animals have only one ovarium developed, as in birds, and both the Echidna and the Ornithorhynchus lay eggs and hatch them. Thus it is that the uterus of the Mammalia becomes modified in the marsupials, so as to be situated without the body, and finally vanishes altogether in the Monotremata.

"If we apply these considerations to ascertain the concatenation of the various groups of animals, in relation to their organs of generation, we find that it indicates one class, the Mammalia, which have an internal hatching organ, called the uterus; another class, the marsupials and

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monotremes, in which this hatching organ is placed without the body, vanishing totally in the latter group, the animals of which lay eggs and hatch them; and finally, a third class, birds, in which this property, which is irregular and limited in the monotremes, becomes fully normal."*

It may perhaps, in this place, be as well to add that DeBlainville and Bonaparte have expressed their opinion that the placental and marsupial animals form separate, distinct, and equal groups; and that Professor Owen, under the article "Marsupialia," in the 'Cyclopædia of Anatomy and Physiology,' after entering fully into the investigation of those peculiarities wherein they differ from the placental quadrupeds, concludes his treatise with the following words: — "These coincidences in the Marsupialia of important organic modifications of the dental, locomotive, vascular, cerebral and reproductive systems, establish the fact that they constitute, with the Monotrèmes, a natural group, inferior on the whole in organization to the Placental Mammalia."† Cuvier also says that the marsupials "form a distinct class parallel to that of ordinary quadrupeds, and divisible into similar orders."—C. R. A.

Now, without giving the slightest colouring to the opinions cited above, it is evident that Cuvier, Owen, Waterhouse, Agardh and Ogilby, have clearly demonstrated the impropriety of mixing up the marsupial with the placental animals. These authors have proved, beyond dispute, that the generation, brain and arterial circulation of the two groups is widely and radically different; that in all these characters the marsupials manifestly approach the

* Mag. Nat. Hist. N. S. iii. 346.

† Cyclop. of Anat. and Physiol. p. 329.

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birds; that in several characters, especially in possessing the marsupial bones, and in the peculiarities of other bones, they resemble the reptiles; that they combine and as it were unite the characters of placentals, birds and reptiles; and seeing that the marsupials can be no longer considered part of the true viviparous series, and that they are physiologically degraded to the oviparous series, we must either constitute for them a new and separate class, or else admit them among birds, reptiles or fishes, which would be as direct a departure from nature as to retain them among the placentals.

2ndly. *Their divisibility or diversity.* There appears to be a series of characters, principally dependent on food, very strikingly exhibited in the placental animals. We find a trace of this in the birds, not indeed confined to, or always indicated by, the divisions of birds in the various systems with which we are acquainted, but in those natural groups of birds which impress their differences forcibly upon us; neither are the differences in birds so strongly marked as in placentals, a circumstance to be inferred from the central position of the latter. The diversified characters of the placentals, which strike me as peculiarly distinctive of the divisions already alluded to, are these:— 1st. The Primates are *Scandentia* or climbers, of which the monkeys are the obvious examples. 2ndly. The Feræ are *Rapacia*, hunters, or beasts of prey, of which a lion and tiger are examples. 3rdly. The Cheiroptera are *Volitantia* or flyers, of which bats are examples. 4thly. The Glires are *Saltantia* or leapers, animals whose fore legs are short, whose bellies touch the ground, whose progressive motion consists of a series of leaps, as rabbits, &c. 5thly. The Bruta are *Repentia* or crawlers, whose

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legs also are short, whose bellies are on the ground, whose progress is repent or creeping, as the ant-eaters. 6thly. The Belluæ are *Ambulantia* or walkers, whose legs are long and strong, who often look as though on stilts, as the giraffe. 7thly. The Cete are *Natantia* or swimmers, whose legs are changed into fins, as the dolphin. These definitions are avowedly deficient in precision, and are often inapplicable to a portion of the animals they are intended to include, but still they appear to be natural: divisions founded on them bear the test of rigid anatomical investigation, and the food and mode of life bear a close relation to the structure. To the technical zoologist such divisions appear puerile, but as he advances from the study of dry technicalities to the study of natural habits and economy, he will perceive that they are neither superficial nor arbitrary. To the uninstructed the simplicity of such divisions must ever prove a recommendation, and it may be advanced in favor of the parallels to which such obvious characters will frequently lead us, that they were, for the most part, pointed out by Linneus. It should, however, be observed with regard to parallels of this kind, that they only exist in an eminent and obvious degree when the groups furnishing the parallels are possessed of many structural characters in common. But this subject will claim further consideration when I attempt to sketch the divisions of birds, &c. To return to the marsupials: if I assign names and characters to certain divisions of placentals, as proposed in a very superficial manner above, and if the marsupials really form a distinct group equivalent to the placentals and birds, they ought to be divisible into minor groups distinguishable by somewhat similar characters. It must, however, be observed,

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that whereas the whales among placentals lead immediately to the fishes, while the marsupials occupy exactly the opposite, and indeed the preeminently terrestrial part of the vertebrate group, these latter cannot, on the principle of approximating like to like, possess a swimming group equal to that of the whales among the placentals.

	PLACENTALIA.		MARSUPIALIA.
SCANDENTIA	Lemur	=	Didelphys
RAPACIA	Hyæna	=	Thylacinus
VOLITANTIA	Vespertilio	=	Pterodactylus ?
SALTANTIA	Pteromys	=	Petaurus *
REPENTIA	Manis	=	Echidna
AMBULANTIA	Auchenia	=	Macropus
NATANTIA	Manatus	=	Ornithorhynchus.

The principal groups of marsupials at present known are indicated by the genera above named. Dasyurus of course classes with Thylacinus, Phalangista with Petaurus, Hypsiprymnus with Macropus, &c.

The number of ascertained existing marsupials compared with that of the placentals is perhaps small, and the series therefore imperfect, but we must recollect that this number is daily increasing. Mr. Waterhouse's volume contains descriptions of 105 species, and many others have been added, although little more than a year has elapsed since its publication. The remains of extinct marsupials appear to be very abundant: many species and a few distinct genera have been ascertained. And here I would indulge in a little hypothesis, and sug-

* The wombat appears to be a direct approach to the Glires.

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gest whether that remarkable extinct animal, the Pterodactylus, was not a marsupial rather than a reptile. I am led to this supposition by certain peculiarities in the bones of Pterodactylus, which, had they been noticed by competent zoologists, I would have detailed, but I fear to trust to my own slender knowledge of these matters, and therefore dismiss the subject, hoping my suggestion may catch the eye of some zoologist competent to decide on its merits.

The pterodactyles, although at present treated as a genus, constitute a much higher division than those usually denominated by that name. Whether these remains eventually prove to have belonged to reptiles or marsupials, the animals must have constituted a group as extensive and as diversified as the Feræ, Cheiroptera or Glires at the present day: the three species, Pter. longirostris, Pter. crassirostris, and Pter. brevirostris, are remarkably distinct forms, and totally different in their dentition.

3rdly. *Their antiquity.* One other subject connected with their distinctness and inferiority, as compared with the placentals, has occurred to me. It is generally admitted by geologists, that the more ancient the formation they examine the lower in the scale have they found the synchronous race of animals. Now I think it is established beyond a question, that in more than one instance the remains of marsupials, birds and reptiles occur simultaneously, without the slightest trace of the synchronous existence of any placental animal. I observe Dr. Mantell has been struck with this, as, after giving a comparative list of the organic remains of the grit of Tilgate Forest and the Stonesfield slate, in the latter of which occur marsupials and in the former birds, he observes, "the remains of Cetacea do not

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occur in these deposits;" * thus calling the attention of his reader to the presence of the higher mammalious animals, when even whales, the lowest on the scale, were not present. Again, the same author speaks of an opossum's jaw found at Stonesfield, as "one of the most precious relics of the past ages of the globe,—*the only known example of mammalian remains in the secondary formations.*"† There is abundant proof of this co-existence of marsupials with the lower vertebrates. Speaking of oolite the same author remarks,—"The land which then existed *was peopled by reptiles and marsupial animals, and clothed with tree-ferns, palms and Cycadeæ.*"‡ Again, in reference to the hypothesis that this earth was in those days a half-finished planet, Mantell writes thus,—"The proof that birds existed in the country of the Iguanodon, —*that marsupial animals inhabited the region of the megalosaurus and pterodactyle,* &c."§ Dr. Buckland, in speaking of marsupials, observes, "The discovery of animals of this kind, both in the secondary and tertiary formations, shows that the Marsupial Order, so far from being of more recent introduction than other orders of mammalia, *is in reality the first and most ancient condition under which animals of this class appeared upon our planet; as far as we know it was their only form during the secondary period;* it was co-existent with many other orders in the early parts of the tertiary period, &c."‖ Professor Owen, in a letter to Dr. Buckland, says, "It is interesting to observe that the Marsupials, including

* Wonders of Geology, ii. 397. † Id. ii. 395. ‡ Id. ii. 408.
§ Id. ii. 443.
‖ Buckland, Bridgw. Treat. i. 73.

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the Monotremes, *form a very complete series, adapted to the assimilation of every form of organic matter;* and no doubt with enough of instinctive precaution to preserve themselves from extermination, when surrounded with enemies of no higher intellectual powers than the Reptilia. *It would indeed be a strong support to the consideration of them as a distinct ovo-viviparous class, if they should be found, as heretofore, to be the sole representatives of the highest class of Vertebrata in the secondary strata.*" I could have quoted much more extensively, and perhaps, in some instances, more decidedly to the point, but I refuse in all instances to adduce the opinions of those who have a theory to support: I never feel quite safe even as to the facts recorded by theoretical writers. Moreover, I cannot avoid the conclusion that I have said enough to establish the marsupials as a distinct class. And now to indulge once more in hypothesis. I believe the allotted period for the existence of these marsupials is drawing to a close. We are becoming daily better acquainted with them: every traveller is collecting information of new species: for years the list of marsupials will increase; but as civilized man and his attendants — the Feræ and the Belluæ — gain a footing in their once peaceful country, day by day and hour after hour their ranks will become thinned, and, through the enterprizing agency of man, this remnant of a highly interesting class will be made known and hurried to its extermination almost simultaneously. I cannot subscribe to the belief that no race of animals is ever to become extinct until the end of all things is accomplished; such a doctrine is in direct opposition to the facts daily and hourly forced upon our notice. I cannot advocate the idea that the Iguanodon is now romping

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with the Ichthyosaurus in some dark "abode of dragons:" I leave such startling hypotheses to the poets of Zoology. Perchance some future Kirby, philosophizing over the *bones* of marsupials, when their *flesh* shall have joined its kindred dust, may construct, in imagination, a marsupian metropolis deep down in the centre of the earth: perchance such a writer may discover, that "they were only fitted for a subterranean habitation," and possessed that peculiar construction of the eye "which enabled them to see in the dark," — even in that utter darkness caused by the intervention of a superincumbent world.

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CHAPTER III.

BIRDS A DISTINCT CLASS.

It may be presumed, from the tenor of the preceding chapters, that I lay great stress on unity of design, and therefore I should not exempt any exterior division from the rules or principles applied in ascertaining the natural arrangement of the normal division. I must, however, admit that there appears to me sufficient ground for supposing the existence of some slight difference; for whereas the contents of normal groups are, by virtue of their central situation, strikingly heterogeneous, those of abnormal groups — such for instance as the marsupials and birds — are also, by virtue of *their* situation, much more homogeneous and accordant *inter se;* consequently their most abnormal forms scarcely recede so far from their respective centres as do those of the placental vertebrates: the birds, therefore, as a group, possibly form a more compact mass than the placentals; a suggestion which, if correct, will necessarily admit of a more extended application; for winged insects appear to occupy a station, as regards the vertebrates, precisely analogous to that of birds, as regards the placentals.

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It seems scarcely possible to imagine a group of animals more uniform, more perfectly distinct, more decidedly marked, than birds. The separation of the marsupials from the placentals was a step that required much consideration, and when once decided on, it appeared necessary to defend it at considerable length, because, in their appearance, marsupials are essentially quadrupeds. With birds the case is altered: there is no child but can instantly distinguish between a bird and a quadruped, therefore the group is on all hands admitted as natural, and requires no argument in support of its distinctness. Were I to attempt to devise *laws for nature* instead of studying *nature's laws*, I should most certainly consider the whole of Mammalia a central and indivisible group, and treat birds, fishes and reptiles, each as a double group. How easy of accomplishment does such an arrangement appear, and how harmonious when accomplished! but whoever gives due weight to structural difference must divide the Mammalia; whoever gives due weight to structural similarity must retain the birds entire. A dichotomous division, apparently a leading characteristic of external groups, is not practicable with birds: we are compelled to treat them as a group perfect in itself. These considerations do not, however, interfere with our considering birds to form the abnormal portion of an external group, and it is in that light that I regard them. The position I have attempted to point out as that of the marsupials, requires that an abnormal group should be closely united to it,—a group possessing in a marked manner certain of its characters, yet combined with others widely different. Birds have the same warm blood and terrestrial habits as the marsupials; the same peculiarities in the systems of circulation and sensation; and the mode

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of generation is in many respects strikingly similar. The differences appear to be — 1st. Those of external appearance. 2ndly. That the anterior limbs of birds are fitted for flight, instead of terrestrial progression: even this important difference is not abruptly accomplished: if we carefully examine the structure of the kangaroo, we shall see that its fore-feet are diverted from their normal employ, and assume the appearance and office of hands rather than of feet; its hind-legs also are altered in their character, and have assumed a considerable similarity to the legs of the ostrich and other walking birds. 3rdly. That the feathers of birds are substituted for the hairs of marsupials; and here again the marsupial form is, as it were, a connecting link, for even their hair is not that of the placentals, but seems of intermediate character between hair and feathers. 4thly. The nest or site of incubation differs: in birds it is external and artificial; not attached to, and a portion of, the body, as in marsupials. Hence it appears that marsupials and birds, considered as a double group, may be distinguished from all other vertebrates by the single fact of their incubation; from all oviparous vertebrates by their warm blood; and from each other by the respective characters of pouch-bearing and nest-making.

Nothing could be more easy than to reduce the class of birds into seven minor groups. Both Illiger and Latreille have made a septenary arrangement of them, and each of these arrangements has usually been considered good and natural. An objection, however, occurs to me, which I think demonstrates the necessity for hesitating a moment before adopting *any* numerical division, unless obtained by some uniform and logical process. The objection is this: twenty-one authors of reputation have proposed as many systems

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of ornithology, and the following list gives the number of primary divisions adopted by each :—

Nitzsch, Schoepss	3
Viellot, Vigors, MacLeay, Swainson	5
Linneus, Cuvier, Dumeril, Carus	6
Latreille, Illiger	7
Scopoli, Latham, Myers, Wolf	9
Temminck	13
Grant	16
Schœffer	17
Brisson	28
Lacepède	38

The above table is extracted from Mr. Kirby's 'Bridgwater Treatise,'* the reverend author himself adopting the septenary division, but this appears rather the result of an ideal value attached to the number seven than from any participation in the views which I have taken of natural arrangement. I think it must be admitted that this great diversity of opinion, as regards numerical division, militates most forcibly against the supposition that *any* number is strikingly apparent.

I cannot pretend to the possession of sufficient knowledge of birds to give anything approaching to a correct division of them, but the principles on which I should conduct the enquiry are those by which I have attempted to prove the distinctness and integrity of the marsupials.

At the very threshold of the enquiry, birds seem to me divisible into those which climb—as we see a parrot when in captivity,—those which fly, those which leap, those

* Kirby's Bridgw. Treat. ii. 444.

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which walk, and those which swim. The simplicity of this arrangement must be obvious, but it certainly is questionable whether it is sufficiently precise: I therefore again have recourse to the Linnean system of parallels, by which I think it will appear that rapacious birds and creeping birds must of necessity be added to the list. Passing over the marsupials, the parallels I would select are those offered by the placentals, for the ranks of these are better filled, and their characters, moreover, are ascertained with that nice precision which results from a long-continued and intimate acquaintance with their habits. In order to demonstrate my meaning, I will define the leading characteristics of each group of the placentals already indicated, and adduce what I suppose its parallel among birds.

1st. *The Scansores* are almost omnivorous; they eat fruits, seeds, insects, &c.: they have the opposable thumb, and are consequently climbing animals: they use the anterior extremities as hands, for conveying food to the mouth and for other purposes: with these characters are combined an unusual quantity of brain, and a peculiarly apt power of imitation. I think there can be but little doubt that the parrots, among birds, emulate the monkeys among placentals: they eat all kinds of food that they can procure; they obtain it in the same situations; they seek it in the same way, — by climbing, — for a parrot actually climbs like a monkey: it does not leap or run like other birds; but, like a monkey, or more especially a lemur, climbs slowly and solemnly from bough to bough: its toes are placed two and two, presenting an exact analogy to the opposable thumb of the Primates; and its foot is constantly used as a hand for conveying food to the mouth: its chattering voice is also similar, and in the gift of speech it rivals

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man himself: its large brain and peculiar tact in imitation are still additional similarities. I should, therefore, place the genus Psittacus as one of the Primates among birds.

2ndly. *The Rapacia.* The dog tribe — I more particularly allude to the wolf or hyæna, for the dog is almost unknown in a state of nature,—are greedy in the extreme: they fill themselves with carrion; they tear open graves to devour the putrifying bodies of the dead; they scent their disgusting food at a distance, and crowd to it from all directions: these are the very characters of the vulture. The genera Felis and Falco in like manner correspond in their thirst for blood and in their pursuit of living prey. I therefore consider the vulture and eagle as the Feræ among birds.

3rdly. *The Volitantia.* They are nocturnal, constantly on the wing; they feed on nocturnal insects, caught as they fly. The same characters are those of the goat-suckers: the swallows would appear to be the diurnal analogues of bats; they differ only in flying by day instead of by night: therefore I look on goat-suckers and swallows as bats among birds, and I am not certain that the owls do not belong here rather than to the Rapacia. I should consider goat-suckers and swallows as bats among birds: they are preeminently *flying birds.*

4thly. *The Saltantia.* The rats, mice, squirrels, &c.: these feed on a variety of substances; seeds, particularly corn, fruits of all kinds, insects, sometimes on small birds, or small animals of their own kind: many of them are remarkable for their attachment to the residences of man: they perforate our walls, make their nests and bring forth their young in holes and crevices of our roofs, wainscots or ceilings; they devour our bread, cheese, lard, bacon, vegetables, and almost every nutritious substance to which they

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can find access; they are remarkable for boldness, yet wariness,—for confidence mingled with distrust; they are for ever intruding, yet for ever on the watch; they are of small size, of infinite number, and of varied form; they are merry, active and playful. Possessing characters in every respect similar are the sparrow tribe:—who is there that has not compared the sparrow to the mouse?—the jay and the magpie are analogues of the squirrel. The sparrow tribe, therefore, are the Glires among birds: these are preeminently *perching and leaping birds.*

5thly. *The Repentia or Ant-eaters.* Their food is exclusively insects, almost exclusively ants: they are mostly without teeth: they wander over the plains in search of ants' nests: when they have found one, they tear it open with their strong claws: the ants, alarmed at the intrusion, rush to the breach, and cover it as with a living mantle; the long extensible tongue of the animal, covered with viscid slime, is then thrust out, and not withdrawn until it is covered with the living prey. In Echidna, the marsupial analogue, "the tongue is slender and very long, and the animal has the power of protruding it to a considerable distance; * * * it lives upon insects, which, like the ant-eaters, it procures by means of its long slender tongue, which is always covered with a viscous matter."* This is exactly the case with the woodpecker: its food is the same; its manner of obtaining it the same. I have watched the common green woodpecker scratching away at the ant-hills, and when the industrious little insects were duly excited it would thrust its tongue into the living multitude: the tongue is in all respects similar to that of

* Waterh. Mars. 304 and 306.

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the ant-eater and Echidna; it has the same slenderness; the same extraordinary extensibility; the same viscid covering; and is always employed for the same purpose. Again, the wryneck (Yunx Torquilla) "*is a feathered ant-eater, and is organized by its Creator to entrap its prey by the very same means as the quadruped ones. Like them, it can protrude its tongue to a very great length*, which is not owing to the structure of this organ itself, but to a peculiar ligamentous sheath in which it usually is contained. Its salivary glands are above an inch long, and shaped somewhat like a tea-spoon. *The saliva they secrete is so very viscid as to be capable of being drawn into threads finer than a hair, and several feet in length; so that, when the tongue is besmeared with it, no insect that touches it can escape. Like its analogues, it darts its tongue into an ant-hill, or lays it on an ant-track, and draws it back into its mouth laden with prey.*"* The woodpeckers are, therefore, ant-eaters among birds: they are preeminently *creeping birds.*

6thly. *The Ambulantia.* The llama, the camel, the giraffe, the horse, the ox, are the largest of their kind: they are strong and stout, and are remarkable for length of leg: while the cats and moles, and rats and mice go with their bellies touching the ground, these huge creatures walk as it were on stilts: they feed exclusively on vegetables, sometimes on the seed, sometimes on the wood, but mostly on the leaf or herbage. The mouse and the sparrow are the unwelcome and furtive attendants on man: these are his welcome and cherished dependants. Among birds, those tribes whence spring

* Kirby's Bridgw. Treat. ii. 464.

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domestic poultry — the storks and cranes, plovers, bustards, ostriches, &c. — are the Belluæ among birds: these are *walking birds*. Nearly all ornithological writers agree in separating the gallinaceous from the wading birds: the following question arises on the propriety of this arrangement—If the Gallinæ and Grallæ are natural and equivalent groups, in which must we place the ostrich and the pigeon? In a group so comprehensive as to include all the walkers, we can admit the ostrich, the cassowary, the apteryx, the bustard and the pigeons; but if we restrict our groups to the Gallinæ and Grallæ, then the ostrich &c. must constitute a third group, and the pigeons a fourth, and when this is done the hopping birds must be equally subdivided, or the divisions will still want uniformity.

7thly. *The Natatores*, or rather the web-footed placentals. Are not these closely represented by the web-footed birds? In some — as in the penguin — the wings have ceased to perform the office of flight, and are used like the paddles of a turtle or manatus as implements of swimming. The penguin and its congeners, therefore, are the Cete among birds. They are preeminently *swimming birds*. It is interesting to observe that, in groups united by such a comprehensive character as that of swimming, there is precisely that variety of general character which so great a latitude would lead us to anticipate. The entire economy of the animal is changed: its habitat is water instead of land; but as the water furnishes for both, every variety of organized life for food, we are led to suppose that each kind would be sought as much by aquatic as by terrestrial animals. We have already seen this observation verified in the swimming placentals, and on investigation we shall find it equally observable in the swimming birds. The gulls are

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the exact representatives of the seals. The duck tribe are the analogues of the Manati, and come on shore to graze precisely in the same manner.

These parallels are brought more strikingly into view when collected, as in the table below. Far from laying claim to any novelty or originality in the idea, I again repeat that I obtained it from the writings of Linneus. Two subsequent writers have tried to improve the fourth parallel in the list; one placing the poultry, the other the waders, as the analogues of the Linnean Glires. I think that such alterations cannot be considered improvements.

	PLACENTALIA.		AVES.
SCANDENTIA	Simia	=	Psittacus
RAPACIA	Felis	=	Falco
VOLITANTIA	Vespertilio	=	Caprimulgus
SALTANTIA	Mus	=	Passer
REPENTIA	Manis	=	Yunx
AMBULANTIA	Camelus	=	Struthio
NATANTIA	Manatus	=	Anser.

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CHAPTER IV.

REPTILES DIVISIBLE INTO TWO CLASSES.

Cuvier divided the reptiles into the true reptiles, "whose heart has two auricles," — C. R. A. — and batrachians, "whose heart has but one auricle."—C. R. A. This division appeared at the time unanswerable. All subsequent authors, whose works I have seen, adopt this dichotomous division. Mr. William S. MacLeay indeed proceeded a step further: anxious to make the Vertebrata subserve his general scheme of dividing all groups into five minor groups, he raised these divisions to the same rank as Mammalia, birds and fishes: this I always thought most unnatural. I compared genera of each class, — for instance, Salamandra and Gecko, — and they seemed almost identical; but still the similarity, perfect as it appeared, was far more than counterbalanced by the extraordinary discrepancy in the system of circulation. I recurred to the question again and again, and always with the same result: the double auricle and single auricle was a greater difference than I could reconcile. When Mr. Kirby's 'Bridgwater Treatise' made its appearance, I was smiling over that worthy gentleman's quaint conceits and most marvellous hypotheses, and somewhat imperti-

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nently condemning the entire work as too imaginative, when the following extract from a letter from Professor Owen suddenly arrested my attention. "I lose no time in replying to your very welcome letter, because I have a statement to make which justifies your disinclination to regard the Reptilia of Cuvier as including two distinct classes. *Not any of the Batrachia have a single auricle; for though the venous division of the heart has a simple exterior, it is in reality divided internally into two separate auricles, receiving respectively, the one, the carbonized blood of the general system; the other and smaller, the aërated or vital blood from the lungs. This I have found to be the case successively in the frog and toad, the salamander and newt, and lastly, in the lowest of the true Amphibia, the Siren lacertina, &c.*"* This taught me an important lesson; — to receive all statements, even from the very highest source, with some degree of hesitation. I recollect no assertion, in the entire range of comparative anatomy, that has been received with such implicit faith as this dictum of Cuvier, on the difference in the structure of the heart in these two groups, yet none could have met with a more flat and decided contradiction. Being thus compelled to renounce the circulation as affording a sufficient ground for dividing the reptiles, and being equally unwilling to abandon a division which so exactly subserved my own idea of natural arrangement, it occurred to me that the metamorphotic form, and more particularly metamorphotic respiration, might form the groundwork of a perfectly natural division; but I soon found that Rana and Salamandra alone possessed these characters, while in

* Kirby's Bridgw. Treat. ii. 413. See also Zool. Trans. i. 213.

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Proteus and Siren the form and respiration were persistent, yet different from the true reptiles. As a last resource, I tried the generation: this, I learned on the united testimony of all authors, was attended with striking and constant peculiarities. In the well-known example of the frog, the male, after enacting a part somewhat similar to that of a midwife, actually impregnates the ova subsequently to their extrusion; and this was said to be a characteristic of the entire group: unfortunately for this hypothesis, I am able to adduce counter testimony — that of my own eyes. In the common water-newt (Lacerta palustris, *Linn.*) a coition—that is a contact—positively takes place, and this not at the moment of oviposition, nor apparently immediately preceding it. In the spring, the male may be seen swimming about, in constant attendance on the female, generally rather above her: the tendency to sexual intercourse may be inferred from an unusual flourishing of the tail in both sexes, more particularly in the male: after divers little amatory preludes, the male descends suddenly to the back of the female; she then twists a portion of her body, so as to meet his embraces: the whole affair is instantaneous, and it is extremely difficult to vouch for any of the details, the water frequented by these animals being mostly turbid: the contact is as brief as that of swallows; but there is no doubt that on these occasions actual coition does take place. This fact is in direct contravention to the published testimony of all herpetologists, except Mr. Bell, who appears to have seen something of the same kind. This author says that "the male seeks and follows the other sex; and the tail of the former is vibrated, and, as it were, smacked, by a motion similar to that of smacking a whip, several times during only a few moments. Rusconi

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asserts, and he has been followed by most subsequent writers, that impregnation is effected without contact; but I have reasons, which it is unnecessary for me to detail here, for believing this to be a mistake, at least in some species. It is sufficient for me to state that those reasons are the result of my own repeated observations."* Thus we find this extraordinary mode of impregnation still more limited than that of metamorphotic respiration: it divides Rana and Salamandra, two genera which all authors agree in considering closely related.

The great objects to be kept in view in seeking to discover natural divisions, when these are not, as in the case of birds, obvious to every beholder, are uniformity and equal value: now although the characters of respiration, circulation and generation, appear of the greatest importance, yet when we see how fractional is the portion of the group of reptiles to be divided from the rest by discrepancies in these particulars, and how vast and heterogeneous is the group still remaining, united by a merely negative character, in one instance because they do *not* agree with Rana and Salamandra, and in the other instance because they do *not* agree with Rana: he must be a bold theorist who shall assert that Rana, or Rana and Salamandra — or even Rana, Salamandra, Proteus and Siren — constitute a class equal to the united groups of Chelonia, Enaliosauri, Crocodilia, Sauria, Saurophidia, Ophidia and Amphisbænia. In fact so great appears to me the objection to so unequal a division, that I consider this inequality alone a sufficient reason for doubting its value.

Having returned this little group into the greater one

* Bell's British Reptiles, 122.

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whence it was abstracted, it still becomes a question whether the reptiles are a single or a double group; whether, like placentals, marsupials and birds, they are constructed on some uniform plan, the variations in which, accompanied by others in their food and economy, will enable us to subdivide them into minor divisions somewhat similar to those of the three classes already investigated; or whether, having dichotomously divided them by some sterling and constant character, each group will admit of the requisite subdivisions.

First then, as to uniformity of structure, it must be evident that "There is no other class of vertebrated animals the different groups of which are formed upon types of structure differing so essentially from each other as these. The eagle and the humming-bird, the ostrich and the petrel, widely as they appear to be separated from each other, not by size only, but by form and habits, still exhibit the same general structure of the skeleton, of the organs of digestion and motion, of the integument, and, in fact, of the whole organization of the body, — the various systems of which differ only amongst the different groups by comparative degrees of development. Even amongst the Mammalia, the whale, with its enormous and almost mountainous bulk, paddled through the deepest retreats of ocean by its short fins, which are modifications of the anterior extremities, and by that broad expanded oar, its fleshy tail, is still formed upon the same general plan of organization as the little light and aërial bat, which flits so rapidly through the regions of air, supported by its thin membranous wings, which are expanded upon slight and linear fingers, the representatives of the same bones which, in the former animal, are contracted into a massive and

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shapeless fin. Nor is there, in the other organs of the body, any more considerable difference of development. *But in the present class, the discrepancies are far more conspicuous, particularly in the whole constitution of the skeleton, in the organs of motion, in the integuments, and many other important portions of their organization.* * * * * In the Chelonians or tortoises, and in the Ophidians or serpent tribe, the extremes of these different types of organization are exhibited. In the common European land-tortoise, Testudo Græca, which may be selected as a familiar example of the former group, the whole structure of the skeleton is brought into the most compact and solid state. The bones of the cranium and face are consolidated into a single and immovable case, with scarcely the vestige of sutures, showing the separation of the different centres of ossification upon which it has been formed:* there are no teeth, but the margins of the upper and of the lower jaw are covered by a horny beak, the latter being received into a groove of the former, and thus closing like the lid of a box; then the whole of the dorsal vertebræ, the ribs, the bones representing the sterno-costal cartilages, and the broad united sternum, are altogether compacted into a case of bone, without any separation between the parts of which it is composed. The anterior and posterior extremities are fully developed, but instead

* The skull, if that term be restricted to the bony covering of the brain, is quite invisible from the exterior, after the removal of the skin: the two temporal muscles occupy an immense space between the exterior bony covering of the *head* and the interior bony covering of the *brain*, which, in these animals, is remarkably small. The heads of a tortoise and a bird present us with the extreme differences of osteological structure.

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of being placed exterior to the thorax they are all of them contained within its cavity, and even the bones of the feet are only extended beyond the horny box which protects them, when the animal is employing them in progression. What a contrast to this solid and compact structure is exhibited by the form of the lithe and tortuous serpent! Most of the bones of the head are permanently separate, those of the upper and lower jaw particularly being capable of great extension; there are perfect teeth; the vertebræ, which are extremely numerous, are susceptible of the most extensive lateral motion; and the ribs, slender and but slightly attached, compensate for the absence of both anterior and posterior extremities, by being themselves the instruments of the animal's progression. It is unnecessary here to enter more particularly into the detail of these curious diversities of structure: *enough has been said to show how far these two groups are separated from each other in their general organization; and it needs scarcely to be added that the diversity of their habits is not less remarkable.* The relations of these groups seem almost to set all the established principles of classification at defiance; nor is there any one system hitherto promulgated which appears to me satisfactorily to solve the difficulty. Those who have made the most philosophical attempts to ascertain the natural system, the grand and harmonious plan upon which all organic creation is believed to have been formed, have concurred in considering the Reptilia as constituting a group of equal value in the vertebrate division of the animal kingdom, with the Mammalia and birds. It may be safely predicated that, if the system to which I more particularly refer be true, all the groups of equal rank must be founded upon characters of equal value and im-

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portance. *That if, for instance, the group of Mammalia and that of birds be equal to each other, each of the other classes — that is to say, every other group of the same rank — must be equal to each other; and also, that the subordinate groups in each of these classes must exhibit the same mutual relations in every case. But if it can be shown that in one class, so called, two* ORDINAL *groups exhibit as great a discrepancy in their relative plan of organization as any two classes do, then the relation of the former to either of the latter is not, and cannot be the same, as that which exists between the latter two; yet in this predicament stand the three first classes of the Vertebrata, the relations of the Mammalia and birds being much stronger and more obvious than those of the Reptilia to either, and the two groups of the latter, which I have just sketched — the tortoises and the serpents — being nearly or quite as far removed by their structure from each other as the birds are from the Mammalia.*"*

Having thus shown that a vast discrepancy exists at the supposed extreme points of the series, restricted as it is throughout these quoted observations to what are called true reptiles, it must next be enquired whether there exists, at any point of that series beginning with the tortoises and ending with snakes, any halting-place where one form decidedly ceases and another as decidedly begins. The question appears to me beset with difficulties, and these are not to be solved by an authoritative dictum: there is no sword wherewith to cut the Gordian knot at a single blow; the entire series must be carefully considered, and its due importance given to every structural difference.

* Bell's British Reptiles, Int. viii.

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And here I cannot but regret that Cuvier, that great master in Zoology, should have left the reptiles in so confused a state, that his arrangement ceases to be a guide, and almost becomes a hindrance in the search after truth. I do not allude particularly to the erroneous character assigned to the Batrachians, but to the general grouping of the other divisions: it will be seen by all who possess the most superficial acquaintance with the subject, that his divisions of Sauria and Ophidia are by no means natural, each of them including species which might, with equal propriety, have been placed in the other. Every fact I have been able to ascertain concerning the reptiles, has tended to confirm my concurrence in the opinions advanced by Mr. Bell, as to the great and irreconcileable difference between the osteodermatous and scaly divisions. In the latter I quite incline to place the naked reptiles usually termed Amphibia or Batrachia, because, as shown above, I can find no sufficient reason for separating them. It is not, however, so easy to decide to which of these groups or classes the crocodiles naturally belong, for the resemblance between these and the lizards seems confined to superficial appearance, although Cuvier makes the former merely a subdivision of the latter. In the skin of the crocodile are imbedded a quantity of bones which, in some measure, assimilate to the osseous covering of the armadillo, but which totally differ from the scaly covering of the lizards, or the naked skin of the salamanders: again, there is a peculiar rigidity in the cervical vertebræ of the crocodiles, caused by small false ribs; indeed, so much is this the case, that when on shore they cannot turn without difficulty, a circumstance which often affords the means of escape to men or animals which they pursue: in the lizards,

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on the contrary, there is a flexibility equally remarkable: in fine, there is scarcely any character of the skeleton, respiration or generation, in which the two groups closely correspond, so that it becomes doubtful whether the crocodiles more nearly approach the tortoises or the lizards. Latreille has united them with the Testudinata under the name of Cataphracta; and I observe that Mr. Gray, in a late Synopsis of the contents of the British Museum, retains the group under Latreille's name, but adds the Amphisbænia, which, like the crocodiles, are covered with square bone-like plates. I am quite disposed to agree with these eminent zoologists in giving full weight to structural characters, rather than yield to superficial resemblances. As something in the way of a connecting link between the tortoises and crocodiles,—mainly distinguished by the bony carapax of the former,—it may be mentioned that it has been asserted that, in the Tilgate Forest strata, the ribs of turtles occur quite unconnected with any portions of a carapax. Unless there is a mistake in this, the animal must combine the structures of crocodile and tortoise.

Now supposing it were established that the Cataphracta form one distinct class, and the Squamata of Merrem—including lizards and snakes—another, how shall we dispose of the fossil genera Ichthyosaurus, Plesiosaurus and Mosasaurus, all of which were closely allied to lizards in the form of their heads. It will be observed, from the very interesting particulars collected by Dr. Buckland* concerning the osteology of these creatures, that they were huge marine lizards, every portion of their skeletons exhibiting similarity to the lizards rather than the crocodiles.

* Buckland's Bridgw. Treat. i. 168—220.

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Ichthyosaurus appears, in the opinion of palæontologists, to have been constructed somewhat like an Iguana, Plesiosaurus like a chameleon, and Mosasaurus like a monitor, but all three differed widely from existent forms in having the legs converted into natant, instead of ambulant organs. Much stress has been laid on the supposed similarity of these paddles to those of dolphins and whales; but, if we admit the power of nature to modify, and adapt the structure of any part to the office which it has to perform, we shall see, in this structure of the Enaliosaurians, no more than that alteration which an altered mode of life absolutely requires: there is no more evidence of an approach towards the whales or dolphins than we see in the ornithorhynchus, penguin or turtle, except inasmuch as the general character of the reptiles more nearly approaches that of the fishes. The extraordinary structure of the ribs in Plesiosaurus, commonly cited as evidence of its approach to the chameleon, seems to me capable of another explanation, *namely*, that they were designed to distend some covering analogous to that of the turtles, required to protect their body from the attacks of other marine animals, particularly the huge Crustacea, whose retreats were among the Algæ in which the Plesiosauri probably lurked for their living prey; still this covering was less compact, and its pressure in deep water, if not obviated by this apparatus, might have been a cause of inconvenience. The explanation hitherto given to these sterno-costal arcs implies an useless freak of nature, *namely*, that the animal was provided with enormous lungs, required by no peculiar economy, but simply to employ this unusual apparatus as a protection. Whatever solution may be in reserve for this extraordinary structure of the Plesiosaurus, it must be admitted

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that, together with the other Enaliosaurians, the really structural and osteological approaches exhibited are to the scaly lizards generally. The common and vague comparison to crocodiles *and* lizards seems to me to arise from a careless blending of these two widely diverse groups; and the similarity to whales arises, as in marsupials and birds, from the necessity for each class to possess a natant or ichthyoid division. With regard to the carapaciform covering, supposing that such a covering really existed, its dissimilarity to that of tortoises is manifested in the fact that the ribs of the Enaliosaurians are always free and distinct.

From these remarks, cautiously compiled, so as to avoid all hypotheses, it seems — 1st. That the crocodiles more closely approach the Testudinata than the Squamata. 2ndly. That the Enaliosaurians more nearly approach the Squamata than any other group, the points of resemblance to certain lizards being decidedly more important than those so often cited to crocodiles and whales. 3rdly. That the result is the formation of two classes, the first nearly coinciding with the Cataphracta of Latreille, distinguished by their bony armour, consisting — 1st, of the Testudinata *certainly;* 2ndly, of the Crocodilia, with some degree of doubt; and 3rdly, of the Amphisbænia, with a greater degree of doubt: the second class, distinguished by the absence of bony armour, would contain — 1st, the Squamata of Merrem *certainly;* 2ndly, the Amphibia of Cuvier, with a degree of doubt; and 3rdly, the Enaliosauri of Conybeare, also with doubt.

When we consider this double group of amphibious animals as it once was, — when we compare the existent Iguana with the Iguanodon of former days, half as long as

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the monument of London and nearly equalling that giant pillar in circumference,—when we contrast the little newt of our ditches with the bones of one described by Scheuchzer, equalling in size those of a human being, and actually paraded before the scientific world as the skeleton of a man who had witnessed the universal deluge, — when we regard the wondrous and most anomalous forms of Ichthyosauri and Plesiosauri,—when we glean from geology such irresistible evidence that this earth was once the abode of multitudes of reptiles, which, for thousands of years, occupied it to the entire exclusion of man and all the placental animals,—and then, turning our eyes to the scattered and persecuted remnant of the reptile world now existent, we can scarcely feel surprised at the difficulty experienced by the systematist in tracing, amid that remnant, the same continuous series he finds among the placental animals, so cherished by him for his own accommodation.

Yet, though I acknowledge myself totally unable, both from a deficiency of materials and deficiency of knowledge, to cope with the detail of arrangement in these proposed classes, it must not be imagined that I admit the slightest doubt as to the existence of those parallels so obvious in the warm-blooded classes. It is highly probable that similarities which in one group shall be most obvious, in another may be traced with difficulty; but the parallels, being almost invariably dependant on food or mode of progression, must naturally in some measure pervade all classes, unless restricted to a single element. Yet even, in such instances, parallels will doubtless be found between the divisions of two groups which are thus equally restricted; in the present instance, supposing the Cataphracta and Squamata to be equivalent classes, a similar reptile

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character will be found in the crocodile and lizards, a similar natant character in the turtle and Ichthyosaurus, a similar ambulant, slow, obese character in the tortoise and toad, a similar reptant and gliding character in Amphisbæna and the snakes: other parallels might be introduced, especially with reference to the placentals: the climbing chameleon is perhaps a representative of a lemur, a parrot or an opossum. These instances are adduced rather as evidence of the existence of the usual diversity of economy, than from any idea of their exactness or precision.

The following parallels between the four most striking divisions of each class are suggested for consideration rather than insisted on as satisfactory. It should, however, be observed, that several of the groups indicated by the genera cited are obviously double, consequently there would be no difficulty in extending the number of divisions.

CATAPHRACTA.		REPTILIA.
Testudo	=	Rana
Chelonia	=	Plesiosaurus
Crocodilus	=	Lacerta
Amphisbæna	=	Ophidia.

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CHAPTER V.

FISHES DIVISIBLE INTO TWO CLASSES.

THE fishes may be divided with greater ease, the chief character being in the skeleton. 1st, the osseous or bony fishes, which are commonly and emphatically known as fishes; and 2ndly, the chondropterygians or cartilaginous fishes, as sharks, rays, &c. "The chondropterygians," observes Cuvier, "can be considered as neither superior nor inferior to the series of ordinary fishes, for several of the genera approach the reptiles in the conformation of the ear and genital organs, while in others the organization is so simple and the skeleton so much reduced that we might be excused for hesitating to place them among vertebrated animals at all. *They therefore constitute a series somewhat similar to the first, as the Marsupials for instance bear a resemblance to the other unguiculated Mammalia.* The skeleton of the chondropterygians is essentially cartilaginous, *i. e.* it contains no osseous fibres, the calcareous matter being deposited in small grains, and not in filaments, — hence the absence of sutures in their cranium, which is always formed of a single piece, but in which, by means of projections, depressions and holes, regions analogous to those of the cranium

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of other fishes may be distinguished. It sometimes happens that moveable articulations which are found in other orders are not met with in this, part of the vertebræ of certain rays, for instance, being united in a single body: some of the articulations of the bones of the face also disappear, and the most apparent character of this division consists in the absence of the maxillaries and intermaxillaries, or rather in their reduction to mere vestiges concealed under the skin, while their functions are fulfilled by bones analogous to the palatines, and even sometimes by the vomer. The gelatinous substance which in other fishes fills the intervals of the vertebræ, and only communicates with them by a small aperture, forms, in several of the chondropterygians, a long cord which traverses the bodies of almost all the vertebræ, without scarcely varying in diameter." — C. R. A. But the great difference appears to me to exist in the generation, that of the cartilaginous fishes approximating to that of birds and marsupials, a complete coition of the sexes taking place, and the young being produced either in a perfect form or as an egg, similar in many respects to that of birds. In true fishes, on the contrary, no actual coition takes place, the ova or spawn after its extrusion being impregnated by the male seminal fluid. As all authors appear to agree on this distinction it is unnecessary to cite the testimony of either.

The following definition by Mr. Miller is very characteristic. — "Fishes, the fourth great class in point of rank in the animal kingdom, and in extent of territory decidedly the first, are divided, as they exist in the present creation, into two distinct series, the osseous and the cartilaginous. The osseous embraces that vast assemblage which naturalists describe as 'fishes properly so called,' and whose

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skeletons, like those of Mammalia, birds and reptiles, are composed chiefly of a calcareous earth, pervading an organic base: hence the durability of their remains. In the cartilaginous series, on the contrary, the skeleton contains scarce any of this earth: it is a framework of indurated animal matter, elastic, semitransparent, yielding easily to the knife, and, like all mere animal substances, inevitably subject to decay. I have seen the huge cartilaginous skeleton of a shark lost in a mass of putrefaction in less than a fortnight. I have found the minutest bones of the osseous ichthyolites of the lias entire after the lapse of unnumbered centuries."*

These views are still further corroborated by the most learned and eminent of all ichthyologists, Lacepède, in whose works we find not simply a tacit assent to the fact that there exist two separate and distinct groups of fish, but great pains taken to show that each contains representatives of the other, and, as though in anticipation, the similarities existing between the two groups pointed out, and a table of these similarities or parallels drawn up in a double series, as under.

CARTILAGINOUS.		OSSEOUS.
Petromyzon	=	Muræna
Raia	=	Pleuronectes
Squalus	=	Esox
Accipenser	=	Loricaria
Syngnathus	=	Fistularia
Pegasus	=	Trigla
Torpedo	=	Gymnotus.

* The Old Red Sandstone, by Hugh Miller, p. 85.

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Thus we have seven groups in each class indicated as parallels and equivalents, so that it would seem that this branch of the enquiry, concerning which my own information and knowledge are utterly at fault, is not likely to present any insuperable obstacle to those who combine a competent knowledge of ichthyology with a desire to corroborate these views of the System of Nature: it is therefore quite needless to occupy space in defending a division which must be almost unanimously admitted.

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CHAPTER VI.

SYNTHETICAL GROUPING OF VERTEBRATE ANIMALS.

HAVING thus indicated the six classes by which I suppose the placental class to be surrounded, it becomes necessary to show in what manner I propose connecting them. I have ventured, at page 12, to suggest that the placentals divide into seven tribes, one of which is normal and central, three subnormal, and stationed at certain distances around the centre, and the remainder abnormal, stationed at a greater distance and alternating with the subnormal tribes. A similar disposition of the classes seems to me in accordance with nature. The placentals form the normal and central group; the marsupials, cartilaginous fishes and pachydermatous reptiles form the subnormal groups; birds, true fishes and true reptiles form the abnormal groups, or, in other words, recede farthest from the central and normal form of man. The subnormal and abnormal groups appear to alternate with each other in this order, — marsupials, birds, cartilaginous fishes, bony fishes, reptiles cased in armour, scaly or naked reptiles; and the relative mutual similarities of the seven groups may be shown thus.—

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AVES.

PISCES CART. MARSUPIALIA.

PLACENTALIA.

PISCES OSSEI. CATAPHRACTA. REPTILIA

I will now endeavour to explain my reasons for supposing the placentals thus surrounded, and for this purpose I must return to the tribes of placentals as indicated at pages 34 and 45, and recapitulate the characters already proposed.

1st. *Saltantia.* With regard to the character by which I have characterized the Glires of Linneus a little explanation appears requisite. I must not be understood as asserting that the entire group is remarkable for its leaping powers or propensities, but rather that the general structure indicates an aptitude for such power or propensity, and is such that leaping may be always accomplished with ease, that being, generally speaking, the mode of progression adopted by choice. The planta, or sole of the hind leg is long, and its entire inferior surface is appressed to the ground: when the animal moves forward, the heels are raised simultaneously. Like the galloping of a horse, its progressive motion is a series of leaps. The rabbit, hare, rat, mouse, squirrel, &c., always gallop if forced into a quick pace; they have no choice of rapid progression; they have no walk or trot, like that of a horse, an ox, or a

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dog; their pace is almost without exception a series of leaps. The fore legs also indicate, in many instances, a disposition to be diverted from their normal employ—that of progressive motion—and to assume the office of hands: the squirrel and dormouse take a nut with their fore feet, as with hands, and thus hold it firmly while they gnaw an aperture with their teeth: mice, rats and arvicoles, do exactly the same with the various descriptions of food which they prefer: rabbits and hares, for a long time together, will stand on their hind legs, and listen or look about if fearful of danger. The jerboas perhaps offer the most striking exemplification of these characters.

This saltant character, combined as it is with the preponderating employment of the posterior legs, seems most decidedly to distinguish the whole class of marsupials. The kangaroos are apparently the normal group, and how obviously do they exhibit the character in question. Even in those animals which to all appearance are not formed for leaping, the inferior surface of the planta is perfectly bare and callous throughout its entire length, as if with constant attrition against the earth. I do not even wish to exclude the wolf-like Thylacinus, almost invariably stuffed and drawn in a digitigrade position. Let me recommend those who wish to controvert this opinion concerning the proximity of the Glires and marsupials, to take a glance at any tolerably extensive collection of the latter, and the very contour of the animals will be enough to convince them.

2ndly. *Volitantia.* "The Cheiroptera, [ornithoid placentals] or bats, have the arms and fingers excessively long, forming with the membrane which occupies their intervals true wings, possessing even a greater extent of

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surface than those of birds; they consequently fly very high and with great rapidity: the thickness of their pectoral muscles is in proportion to the motions they have to execute, and *in the middle of the sternum there is a ridge provided for the attachment of these muscles, as in birds.*" — C. R. A. Mr. J. Quekett, in a paper in the 'Transactions of the Microscopical Society of London,' has clearly shown that the hair of bats consists of a shaft covered with scales towards its apex, but naked at its base, which, besides the value of the discovery as a physiological fact, proves, as the author justly observes, that the scales must grow after the shaft has appeared above the cuticle, thus pointing out the analogy between this part of a hair and the quill of a feather. "Physiologists," concludes Mr. Quekett, "have been long agreed that hair and feathers are constituted upon one uniform plan, but as yet there have been many links wanting to complete the chain of evidence upon which this analogy is maintained. The hair of the animals in question will certainly supply the links to a certain extent, and as the zoologist would tell us that they resemble quadrupeds principally in their mode of reproduction, and birds in their mode of progression, so the microscopic observer now can say that they resemble both in the structure of their hair."* The evidence on this subject appears to me so extremely conclusive that it is not desirable to seek or adduce additional proofs.

3rdly. *Rapacia.* The animals of this group of placentals are not so readily to be distinguished by any peculiarity of their gait or pace, as by the formula of their dentition, the simplicity of their intestines, their extraor-

* Trans. Mic. Soc. i. 61.

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dinary power of smell, their strength, agility and flexibility, and, in a word, by all those qualities which fit them for a life of rapine: hence we can neither distinguish them as flying, leaping, climbing, creeping, swimming, or walking animals, but preeminently and peculiarly as rapacious animals. Still it must not be understood that I am either unacquainted with, or regardless of, the fact that some of the families — as the bears — can subsist entirely on a vegetable diet, while others — as the shrews, hedgehogs and moles — live almost exclusively on insects. These are the exceptions, and are evident departures from the normal character of rapacity; but they are exceptions which will by no means justify the disintegration of the group. Now this excessive rapacity, — this combination of qualities adapted to predatory life,—this facility of discovering, overtaking, overcoming, lacerating, slaughtering, devouring and digesting, — are peculiarly the attributes of the cartilaginous fishes. Nothing can be more extraordinary than the power of smell possessed by the shark: it serves, as a naturalist of eminence has observed, both for eye and ear: like the vulture, the shark snuffs carnage from afar, and its entire race are the scavengers of the ocean. The terrestrial Rapacia, although viewed by us with disgust or dread, do but faintly shadow forth the horrors committed by the monsters of the deep. Some of the terrestrial Rapacia— such for instance as the common otter, and more particularly the sea-otter, a perfectly distinct form, — have a decided predilection for the water; but these must not be employed as connecting links with the class of cartilaginous fishes: a moment's consideration would be sufficient to assure us that they lead to the seals among the swimming placentals.

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4thly. *Natantia.* In the swimming or ichthyoid placentals the legs are transformed into fins, and have become organs of progressive motion in water. These animals we find so completely assuming the figure and habits of fishes, that there can be no necessity for dwelling on a similarity so obvious and so universally admitted.

5thly. *Ambulantia.* In this tribe, the feet, instead of being divided exteriorly into fingers or toes, as in most of the other tribes, are bound together in a solid mass, the extremity of which is furnished with one or more horny bodies called hoofs. The mode of progression is eminently terrestrial, and by an alternate movement of the legs: it may also be said to be eminently digitigrade, the toes or hoofs alone coming in contact with the ground. The two pairs of feet closely resemble each other, the fore pair never being used as organs of prehension. The skin is remarkable for its thickness; whence the name of Pachydermata. This tribe appears to me to indicate an approach to the tortoises. The similarity of the solid foot is very remarkable, as also the close correspondence of the two pairs of feet, and the utter impossibility of the application of either pair to purposes of prehension or flight. The only modification which the feet ever undergo is the transformation into paddles, and consequent adaptation to progressive motion in water.

6thly. *Repentia.* In this group the legs are remarkable for their shortness, the bellies of the animals nearly touching the ground: this peculiarity gives them a crawling, herpetoid or reptile gait and appearance, greatly enhanced by the scaly covering in which many species are encased. There appear to be two divisions of this tribe, the armadilloes and the anteaters; the former "are completely

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invested with a hard and scaly shell, formed of little compartments like paving stones. This substance forms a shield over the forehead, another very large and convex over the shoulders, &c." — C. R. A. We are indebted to Geology for disclosing some most remarkable animals allied to the armadilloes; among these the genus Glyptodon of Owen stands preeminent: in size it must have greatly exceeded any of its congeners, possessing a bulk much superior to that of an ox. The remarks of Dr. Lund on the extinct fauna of Brazil show that the armadilloes of former times were much more numerous not only in individuals, but also as regards species. There is a very close correspondence between this group and the tortoises, so obvious indeed as to have engaged the attention of many eminent naturalists. The remaining group of herpetoid placentals or ant-eaters exhibits a similarity to the lizards as striking as that of the armadilloes to the tortoises. The teeth in this tribe are remarkable for their variation in form, number and situation, some of the genera having an unusual quantity, while others are entirely destitute of them. This character is also that of the class Reptilia.

With regard to the relative position of the classes as proposed at page 70, little can be said; the respective sites of the subnormal and abnormal groups seem rather due to their correspondence with certain tribes of placentals, than to the existence of any chain of structural similarities *inter se*. I must not, however, be understood as saying that such a chain is non-existent. I only admit that it is unproven, and, in some instances, would be difficult to prove, without a more severe analysis of structure and generation than the limits of an essay like the present

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will allow. And were we to regard external form, we should find a stumbling-block at the very threshold of the enquiry: where, for instance, shall we detect a similarity between birds and cartilaginous fishes, unless we can conscientiously pin our faith on such superficial resemblances as that of the fossil Pterichthys? "Of all the organisms of the system, one of the most extraordinary, and in which Lamarck would have most delighted, is the Pterichthys, or winged fish, an ichthyolite which the writer had the pleasure of introducing to the acquaintance of geologists nearly three years ago, but which he first laid open to the light about seven years earlier. Had Lamarck been the discoverer, he would unquestionably have held that he had caught a fish almost in the act of wishing itself into a bird. There are wings which want only feathers, a body which seems to have been as well adapted for passing through the air as the water, and a tail by which to steer."* This similarity is, however, no better than imaginary.

I am well aware how strenuously quinarian systematists have insisted on the superficial resemblance existing between the beak of a bird and that of a tortoise, but I cannot think such similarities sufficient to justify an approximation of these groups. A bird is the swiftest, a tortoise the slowest of animals: the blood of a bird is remarkable for its heat and the briskness with which it circulates, that of a tortoise for its coldness and sluggishness: the respiration of a bird is remarkable for its perfection, that of a tortoise for its imperfection: a bird is most susceptible of hunger and thirst, a tortoise most enduring: a bird is most

* 'The Old Red Sandstone; or New Walks in an Old Field.' By Hugh Miller. Ed. 2. 1842, p. 70.

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readily killed, a tortoise most tenacious of life. The Almighty has scarcely created animals whose characters present so complete a contrast. I cannot, therefore, avoid the conclusion that they must be placed at the opposite points of the vertebrate circle, as already suggested at page 70.

The distinguishing characters of the vertebrate group are these: —the brain and principal trunk of the nervous system are enclosed in a bony envelope formed by the cranium and vertebræ: to the sides of this intermedial column are attached the ribs and bones of the limbs which form the frame-work of the body: the muscles generally cover the bones whose motion they occasion.

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CHAPTER VII.

SYNTHETICAL GROUPING OF THE ANIMAL KINGDOM.

HAVING thus built up the province of vertebrated animals, and having assigned to these apparently heterogeneous forms a common and clearly natural character or bond of union, it next becomes desirable to inquire briefly into the structure and systematic divisibility of the invertebrate tribes, by which I believe the vertebrate to be surrounded. United by several very marked characters, and by these also clearly shown to be inferior to the Vertebrata, it is still necessary to seek among them other characters by which to distinguish them *inter se*, and this is by far the most difficult part of this synthetical enquiry, and the one of which the result is least likely to be satisfactory, on account of the general ignorance which prevails on almost every branch of the subject; the insects perhaps (owing to the labours of Swammerdam, Willughby, Ray, Linneus, DeGeer, Fabricius, Clairville, Latreille, and our illustrious countryman, Leach), may be deemed an exception, and it was through the assistance afforded by these able pioneers that I was enabled to attain sufficient knowledge of insects to employ them formerly as affording the best illustration and test of my opinions.

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The brain among invertebrate animals is at its lowest state of development: neither confined by a bony covering nor centred in one locality, it becomes dissipated through the body, losing its excessive power of sensation, yet communicating an intense vitality to every part of the frame. The reasoning faculty which, in descending from man to the other Primates, then to the abnormal placentals, and then to the abnormal vertebrates, has become fainter and fainter, ceases altogether in the invertebrate tribes, and instinct, unaccompanied by reflection, reigns supreme. I have elsewhere said that while the concentrated brain reflects the diffused brain acts: it impels to a certain course, and though destruction may possibly be the result it leaves no choice; it will be obeyed. Let it not however be supposed that the reasoning faculty mounts regularly upwards from the monad to the man; this is by no means the case: each group is a system in miniature, and its normal central form is in all probability superior to the abnormal forms of even a superior group. It must on no account be supposed that the majority of the monkeys, lemurs or sloths, are animals intellectually superior to the dog, the horse, or the squirrel, because certain osteological peculiarities tend to place them in the same group with man. The very converse of this is the fact; and much as we find written concerning the human character and attainments of the orang-otan, I should be inclined to consider him but little in advance of his brother apes, and some of these decidedly inferior to many quadrupeds which exhibit a much less distinct resemblance to the typical form of man.

The skeleton, like the brain in the invertebrate tribes, loses its character, and finally ceases to exist: traces of

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it are observable in some, while in others its functions appear to be performed by an indurated skin, which serves for the attachment of the muscles. The circulation is equally imperfect, never (I should suppose) altogether absent, but often unconfined by the vessels which invariably limit its course in the vertebrated groups. Respiration undergoes a like modification; instead of being confined to the lungs it is ramified more or less through the entire body.

Cuvier tells us that before his time modern naturalists divided all invertebrate animals into two classes,—insects and worms,—a method which he was the first to attack; and in a paper read before the Society of Natural History of Paris, on the 10th of May, 1795, and printed in the 'Decade Philosophique,' he presented a new division, in which he defined the characters and limits of Crustacea, Insects, Echinodermata, Zoophytes, Mollusca and Worms. Subsequently, however, he distributed the animal kingdom into four great divisions, under the names of Vertebrata, Mollusca, Articulata and Radiata. These divisions partially correspond with those previously proposed, the Articulata comprising three of the earlier groups,—namely, Worms, Crustacea and Insects,—and the Radiata two, Echinodermes and Zoophytes. In the 'Regne Animal' the Annelides or red-blooded worms are again cut off from the other articulated animals, and placed immediately after the Mollusca, so that there is really little discrepancy between the views entertained by this great zoologist at different periods of his career; his earliest views favoring a division into seven single groups, which by degrees appeared to resolve themselves into a single one and three pairs. The discrepancy therefore between the views of this great man, as expressed at various periods of his bright

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career, rather implies a difference in the mode of explanation than a change in his opinions, and I feel convinced that this distribution of animals, whether into four or seven groups, rests on so solid a foundation, that it will be a task of considerable difficulty to disprove its very close accordance with nature.

Considering the Vertebrata as the central and normal division of the animal kingdom, I would suggest that the Cuvierian divisions of invertebrates occupy this position around them. —

INSECTA.

ECHINODERMATA. *CRUSTACEA.*

VERTEBRATA.

ZOOPHYTA. *MOLLUSCA.* *VERMES.*

Crustacea, Echinodermata and Mollusca being the subnormal; Insecta, Vermes and Zoophyta the abnormal groups. Before assigning my reasons for supposing this to be the natural relative position of the primary groups of the animal kingdom, I must introduce a few remarks as to the characters to be consulted. Hitherto the whole of my observations have referred to animals constructed after the vertebrated plan or model, and the variations from that model have afforded definite and tangible characters: now other plans come under consideration.

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It will be observed by those who take an interest in comparative anatomy, that the vertebrated animals are normally four-limbed. It is quite obvious that this character is not confined to the normal or central group which have so frequently been described as quadrupeds. The possession of two pairs of jointed organs of locomotion is a character of vertebrated animals generally, and not a character confined to a single class. Amongst those which are called the lower vertebrated animals, we shall find that these organs of locomotion have undergone great modification. In some classes we find animals — as snakes, eels and lampreys — in which scarcely a vestige of limbs remains: in the marsupials alone can they be said to maintain, with any stability, their normal employ of terrestrial progression: in birds their office appears to be equally divided between the earth and air. Now in the invertebrated animals so great a change of structure has taken place, that all attempts to trace these four implements of locomotion must entirely fail. It has been said of plants that they are animals turned inside out: this definition strikes me as applicable to the invertebrate, when contrasted with the vertebrated groups; the former may be characterised as inverted vertebrates. Hence we not only do not find, but cannot expect to find, any trace of similarity between the legs and wings of vertebrates and invertebrates; the same is, in a great degree, the case with the organs of the senses. Sight, hearing, smell, taste, touch, and locomotion, were requisite for animals adapted for living on the earth, and their Almighty Creator has been pleased to supply these powers to animals constructed on a variety of plans: each province of animals had to live, feed, move, breathe and breed on the same earth, and therefore a degree of simi-

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larity in the means provided for the attainment of these ends is to be anticipated; but those authors appear to me far too imaginative who fix the site of a faculty without tolerably strong evidence of their conclusions being just. We see that a butterfly and a swallow are furnished with implements adapted for rapid progression through the air. In both instances we call these implements wings, a name so sanctioned by usage that it would be futile to attempt to alter it in either instance. If, however, we carefully investigate this subject,—if we endeavour to trace out the identity of these so-called wings, we shall find the matter one of infinite difficulty; and I would rather undertake to prove an identity between the lungs of the swallow and the wings of the butterfly, or between the ribs of the swallow and the legs of the butterfly, than between the same parts of the two animals. The same remark applies still more forcibly to the senses of sight, smell and hearing, all of which have been located in every possible part of an insect's head. Our most distinguished British entomologist, Mr. Kirby, fixes the nose of a beetle where he finds that organ on the human face, and some authors of less celebrity have dignified the antennæ by the name of ears, while others strenuously contend that they perform the office of eyes or nose; but—*quicquid ex phenomenis non deducitur hypothesis vocanda est* — I consider all such nomenclature as this, hypothesis of the worst and most injurious kind. I would even go so far as to say that I consider the universally accepted terms of wings, legs and arms in insects, spiders and cephalopods, as metaphorical, and to be received only as indicating a similarity of employ. The more closely we investigate the subject and enquire into its various bearings, the more thoroughly shall we

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be convinced of the total want of identity between the eye or wing of a butterfly and the eye or wing of a swallow: if we attempt to separate the component parts of these instruments, and to subject them to an uniform anatomical nomenclature, we shall find the task utterly impracticable. On the contrary, if we dissect the eye or arm of a man, we shall be able to trace most of its component parts in a bird, a kangaroo, a lizard, a tortoise, a perch, or a shark; or if we dissect the leg of a butterfly, we shall be able to trace *its* component parts in the leg of a gnat, a bee, a beetle, a grasshopper, a cicada or a dragon-fly.

Still do I consider the end far greater than the means; the faculty more important than the machinery by which it is obtained; the propensity of greater consequence than the structure through whose instrumentality it is gratified. It appears to me that a correspondence in some well marked character in the mode of life, — such for instance as rapid and unwearying flight or the total inability to fly; rapidity or slowness of terrestrial progression; great power of swimming and inability to leave the water or the propensity to shun it altogether; savage unrelenting ferocity and thirst for blood or the inability to appropriate any other than vegetable food; gluttonous and insatiable appetite or the power of total abstinence; perfect and quick respiration or the power of suspending this function for an almost indefinite period;— should be regarded as of greater importance, and as offering analogies of far higher value, than those metaphorical and often imaginary similarities of structure to which such overwhelming importance has hitherto been attached. *Real correspondence* in structure stands quite preeminent, and when we lose sight of this, when we abandon the group bound together by this real

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correspondence, we can only seek for correspondence in economy. In this spirit I have pointed out the connexion between bats and birds, anteaters and reptiles, whales and fishes; and in this spirit I shall endeavour to trace a certain but less distinct connexion between these abnormal vertebrates and those vast groups of invertebrates by which I suppose them to be surrounded.

1st. *Saltantia.* The Crustacea appear to me to occupy the highest rank among the invertebrate classes: their circulation is distinct, double, and of a much higher character than that of insects; their respiration is normally by branchiæ, but in some of the tribes by tracheæ; the brain is concentrated in the higher orders, and is very distinct; the senses of sight, smell, taste and hearing, appear to be also very distinct. There are two peculiarities connected with the generation of Crustacea that are worthy of much attention; the first is that the young ones or eggs after extrusion are transferred to the surface of the abdomen, where they remain frequently for weeks, increasing slowly in size: the second peculiarity is, that when these eggs first become independent beings, possessing an existence and locomotive power distinct from that of the parent, they assume a form different from that of the parent animal. For this discovery, one of the greatest of which modern Zoology can boast, we are indebted to Mr. J. V. Thompson. I think, after the detailed account given of the mode of reproduction in the marsupial animals, its similarity to that of macrourous Crustacea cannot fail to strike every reader. The marsupials are the highest of implacental vertebrates, the Crustacea highest of invertebrate animals, and their most striking peculiarity — that of their anomalous reproduction — is strictly identical.

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The saltant character might perhaps be traced, even in an eminent degree, in some of the genera belonging to this group; but this is foreign to my purpose. The preponderating use of *legs* throughout the group — while in the following group they are accompanied by wings, and in the remaining four are totally absent—is sufficient to establish the propriety of considering this group as equivalent to that of the Saltantia in minor divisions.

2ndly. *Volitantia.* The winged insects — and such alone are comprised in this group — are preeminently distinguished by brilliancy of colouring, rapidity of aërial progression, universally distributed respiration, and extraordinary development of instinct, so peculiarly displayed in nidification. These appear to me the characters whereby we should most readily distinguish birds.

3rdly. *Rapacia.* The star-fishes and urchins are distinguished by having their covering composed of those osseous or calcareous plates with which many of the cartilaginous fish are so completely invested. They are rapacious animals, of great voracity, feeding on testaceous Mollusca and Crustacea. The mouth, particularly in Echinus, is one of the most formidable and powerful known to naturalists: its structure has long been the theme of admiration: it is described by Aristotle, Lamarck and Cuvier: it appears to be possessed of the power of masticating, and almost instantaneously converting into pulp the hardest shells. In these characters we must perceive a striking resemblance to the cartilaginous fishes. The extinct Pterichthys was almost an Echinus.

4thly. *Natantia.* These are the lowest, most simple and most shapeless of all animals: they are all of them aquatic, most of them marine. The term Zoophyta or

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animal-plants applies only to a fractional part of the almost numberless tribes of beings which are included in this primary division of animals. Like fishes, they are perfectly destitute of organs adapted for progressive motion on land. Each group is remarkable for its want of limbs.

5thly. *Ambulantia.* The general appearance of any shell-bearing mollusk crawling slowly on its belly, its head and tail alone protruding from its heavy, solid and compact shell, certainly brings forcibly to our recollection the figure, proverbial slowness, and mountainous covering of a tortoise, The terrestrial Mollusca devour food similar to that devoured by the tortoises; their greediness in feeding is similar; their capability of fasting similar; their tenacity of life similar. The resemblance is not entirely that of general economy; on the contrary, in the Cephalopods, there is a structural similarity: the mouth is something like that of a tortoise; it is composed of two strong, horny, toothless jaws, the lower closely fitted in a groove of the upper: the tongue, ear and eye, also present considerable resemblance. The mode of reproduction, by means of comparatively large and nearly spherical eggs confided to the earth, is also similar.

6thly. *Repentia.* The general figure of worms — whether we regard the true earth-worms or the somewhat aberrant leeches and other tribes, their elongate form, their want of legs, their wriggling progressive motion — seems to be represented with perfect fidelity by the entire class of scaly reptiles; and if we compare more accurately the structure of Cæcilia and Lumbricus, and remark the irregularity with which the bodies of both are divided into rings, we cannot but be struck with a similarity which

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seems to approach identity. The mode of respiration, very clearly ascertained in the leech, brings us back to the Myriapoda, one of the constituent classes of the province of Crustacea, with which we commenced the series.

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CHAPTER VIII.

THE ARTICULATA DIVISIBLE INTO TWO PROVINCES.

It should perhaps be stated that this chapter is exclusively entomological, and may be omitted by those naturalists who have not made insects their particular study: to entomologists, on the contrary, it is important, as affording them the means of testing the truth of my proposition. If there is truth in any proposition as applied to the animal kingdom, I conceive it should also be true when applied to an integral portion of that kingdom. I cannot imagine the Almighty will, the creative fiat, as capable of failure in carrying out its designs, or as exercising at random infinite and irresponsible power. I cannot estimate the effects of such power by an appeal to human power, or universal intelligence by a comparison with the insignificant mental capacity of man, otherwise I should not seek uniformity or harmony in such a stupendous mass. But believing that I have discovered evidence of design or system in the animal kingdom as a whole, I believe the same design will permeate its parts; and I imagine that insects offer an illustration of this uniformity of design.

To proceed with the enquiry: it will be seen by a reference to the works of all the more able entomologists

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that the worms, notwithstanding the ring-like divisions so often observable in their bodies, are not supposed to range with the other Articulata. The remaining groups have been denominated Condylopoda, from the circumstance of their invariably possessing articulated legs. A certain portion of them also possess wings, and it will be seen how much stress has been laid on the absence or presence of wings, and on differences in their structure.

The various arrangements or systems of Entomology have been founded on widely different characters. An excellent sketch of these will be found in the 48th letter of Kirby and Spence's 'Introduction to Entomology.' The learned authors divide the history of Entomology into seven eras. 1. The Era of the Ancients. 2. The Era of the *revival* of the Science after the darkness of the Middle Ages. 3. The Era of Swammerdam and Ray, or of the Metamorphotic System. 4. The Era of Linneus, or of the Alary System. 5. The Era of Fabricius, or of the Maxillary System. 6. The Era of Latreille, or of the Eclectic System. 7. The Era of MacLeay, or of the Quinary System. The second era is scarcely worthy of being so called, and the only relic of it that has reached us is the name of Annulosa, which Albertus Magnus appears to have first employed as a designation of the winged insects. The seventh era scarcely requires a notice, as it neither supplies new materials nor recommends any new characters as available for the formation of divisions. Mr. MacLeay's work is a brilliant but isolated event rather than an era: it may give valuable hints for others,—and certainly in the bright idea of circles it has done so,—but it bears the same relation to the true system as does the Ptolemaic to the Newtonian. Ptolemy imagined the planets to revolve, but Newton

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found that the sun was the centre of their revolutions.—Moreover, the Quinarian system can scarcely be said to form an era, because, with the single and unfortunate exception of Dr. Horsfield, no entomological author has adopted its peculiarities, but each has continued to employ various modifications of the Eclectic as though no other had intervened. Again, the Eclectic system seems to date from DeGeer rather than Latreille, and is therefore anterior to that of Fabricius.

As I cannot agree with the learned writer who has laid down these entomological eras, in having "recourse to the most ancient of all records, the Old Testament," I must date the first era somewhat later, and synchronous with Aristotle, with whom it originates, and, as far as progression is concerned, terminates also. The following view of the Aristotelian system is extracted from the 'Introduction to Entomology.'

ARISTOTLE.

	CLASSES.	
Pterota or winged Insects.	Coleoptera	= Coleoptera.
	Pedetica	= Orthoptera.
	Astomata	= Hemiptera.
	Psychæ	= Lepidoptera.
	Tetraptera majora	= Neuroptera.
	Tetraptera opisthocentra	= Hymenoptera.
	Diptera	= Diptera.
Pterota simul et Aptera.	Myrmex	= Formica.
	Pygolampis	= Lampyris.
Aptera.		

When we consider the striking difference between the winged and apterous ants, and between the male and

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female glowworm, we shall feel inclined rather to admire the judgment displayed in associating each of these with its fellows, than to criticise the very pardonable error of separating these insects from their congeners in Hymenoptera and Coleoptera. It is really remarkable that although considerably more than two thousand years have elapsed since this system was first promulged, so little has been done towards improving it. The systematist of the present day has no choice but to go back two thousand years for the primary division or classification of insects, and I may add that nothing but a desire to make myself clearly intelligible prevents my employing the nomenclature as well as the divisions proposed by Aristotle.

The metamorphotic system of Swammerdam, Ray, and Willughby, is a great and well-marked era in the progress of the science: the merit of first introducing metamorphosis as a basis for the formation of natural divisions is due to Swammerdam, but our countrymen, Willughby and Ray, fully adopted his views, and improved on some of his divisions. I must not, however, be understood as assigning a very high share of praise to our English advocates of the metamorphotic system: regarding Ray as the most brilliant naturalist between Aristotle and Cuvier, I rather shrink from connecting his name with a system which he had no merit in portraying.

In France, Lamarck proposed a metamorphotic system still more complete than Swammerdam's: in this he calls the pupa in Lepidoptera and Diptera by the name of *chrysalis;* in Hymenoptera and Coleoptera by the name of *munia;* and in Orthoptera and Hemiptera by that of *nympha;* thus emphatically expressing his view of their complete distinctness.

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SWAMMERDAM.

	CLASSES.	
Metamorphosis	Obtected.	Lepidoptera.
„	Coarctate.	A part of Diptera, (the Muscidæ, &c., in which the so-called pupa appears as though turned in a lathe), and the Ichneumones minuti.
„	Incomplete.	The remainder of the Diptera, Hymenoptera and Coleoptera, and a part of the Neuroptera.
„	Semicomplete.	Orthoptera, Hemiptera, and a part of Neuroptera.
„	Complete.	Aptera.

The modern entomologist will at once see the impropriety of thus dividing the Ichneumones: the origin of the error may possibly be traced to the appearance of the cocoons of the little Microgaster, which infests the larva of the common cabbage-butterfly. The order of sequence is reversed in the above table.

The Era of Linneus is next in succession, and from this great man dates the binominal nomenclature which has since been universally adopted. His division of insects depends solely on the wings: in this it resembles that of Aristotle, to which I can scarcely say that I consider it superior, excepting inasmuch as the definitions are given with a surpassing brevity and point.

It will moreover be observed that Aristotle's striking division of all the Articulata, with the exception of two genera, into winged and apterous, is abandoned by Linneus, who comprises the whole of the apterous articulates in an order equivalent to Lepidoptera or Diptera: this has the appearance of a retrograde step rather than an improvement: his system is given on the next page.

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LINNEUS.		ORDERS.
Wings 4	Superior, crustaceous, with a straight suture	Coleoptera.
	„ semicrustaceous and incumbent	Hemiptera.
	All imbricated with scales	Lepidoptera.
	Membranous, anus unarmed	Neuroptera.
	Membranous, anus aculeate	Hymenoptera.
„ 2.		Diptera.
„ 0.		Aptera.

In this arrangement the modern entomologist will be surprised to find the Orthoptera and Hemiptera blended into one class, but these are in reality closely approximate, and, were it not for the important characters of the mouth since so strenuously insisted on, must be regarded as indivisible.

Linneus was almost immediately followed by DeGeer, than whose name Entomology can boast no greater: he restored the name of class to the Linnean order; he separated and clearly distinguished Hemiptera and Orthoptera, and assigned precise characters to four new classes, all of which have been adopted and named by one or other of our modern entomologists; Cicada, &c., corresponding with the Homoptera of Leach; Phryganea, &c., with Trichoptera of Kirby; Coccus with Phaceloptera of Laporte; and Pulex with Aphaniptera of Kirby: he introduced the variations of the mouth as affording characters for primary division, yet has the rare merit of combining them with the characters previously in use. He divided the apterous articulates into four classes, of which the common flea constituted the first, and was distinguished from the rest by the fact of its undergoing a metamorphosis. It was not in system

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—although in this respect superior to his contemporaries—that DeGeer was so particularly great; as a physiologist he deserves still higher praise; and as the historian of insect economy he stands unrivalled: he chose the three highest branches of the science, and his labours are diffused through all the compilations on Entomology from the date of their publication to the present hour.

DeGeer was followed by Fabricius, whose bold, skilful and highly artificial system, founded on the mouth alone, is known to all entomologists: having no longer any need of the wings as affording characters, he of course rejected the names which were derived from them, and substituted others altogether different; names which, however, have been considered by all subsequent writers as too harsh and unpleasant to be perpetuated. There is an evidence of tact, talent and superiority, about all that Fabricius has written; his very errors evince an air of authority which it is difficult to resist. The great utility of the Fabrician system consists in the assistance it affords us when blended with those which preceded it. It will be useful, as showing into what extravagancies the most talented men may be led by a favorite hobby, to give an idea of this system; although it is but an act of justice towards this extraordinary man, whose works may be regarded as of standard authority in Entomology, to say that he was aware of the artificial character of his bizarre arrangement, and seems to have planned it with a view to furnishing a ready guide to the genus and species of an insect, rather than as likely to afford the slightest clew to the System of Nature. In France, the nomenclature of Fabricius, as regards genera and species, has taken precedence of the prior nomenclature of Linneus.

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FABRICIUS. CLASSES.	LATREILLE. ORDERS.	CLAIRVILLE. SECTIONS.	
With two pair of jaws, the lower pair palpigerous.			
Eleutherata	Coleoptera	Elytroptera	Mandibulata of Clairville.
Ulonata	Orthoptera	Deratoptera	
Synistata	Thysanura, Psocus, &c.		
Piezata	Hymenoptera	Phleboptera	
Odonata	Neuroptera, p.	Dictyoptera	
Mitosata	Myriapoda (*class*)		
With two pair of jaws, the lower not palpigerous.			
Unogata	Arachnida pulmonaria		
With more than two pair of jaws.			
Polygonata	Crustacea edentata (*division*)		
Kleistognatha	„ maxillosa (*division*)		
Exochnata			
Suctorial insects.			
Glossata	Lepidoptera	Lepidioptera	Haustellata of Clairville.
Ryngota	Hemiptera	Hemimeroptera	
Antliata	Diptera	Halteriptera	
	Parasita		
	Arachnida trachiaria		
	Rhipiptera		

Fabricius was followed by Latreille and Clairville, whose nomenclature is arranged above in parallel lines with his own, in order that the nomenclature of Latreille may afford an explanation of the others: it will also show how completely Clairville's divisions of Mandibulata and Haustellata were forestalled by Fabricius: that author indeed placed the whole of the Crustacea and Arachnida between Clairville's divisions. Fabricius, in like manner, was forestalled by DeGeer in deriving divisional characters from the variations of the mouth.

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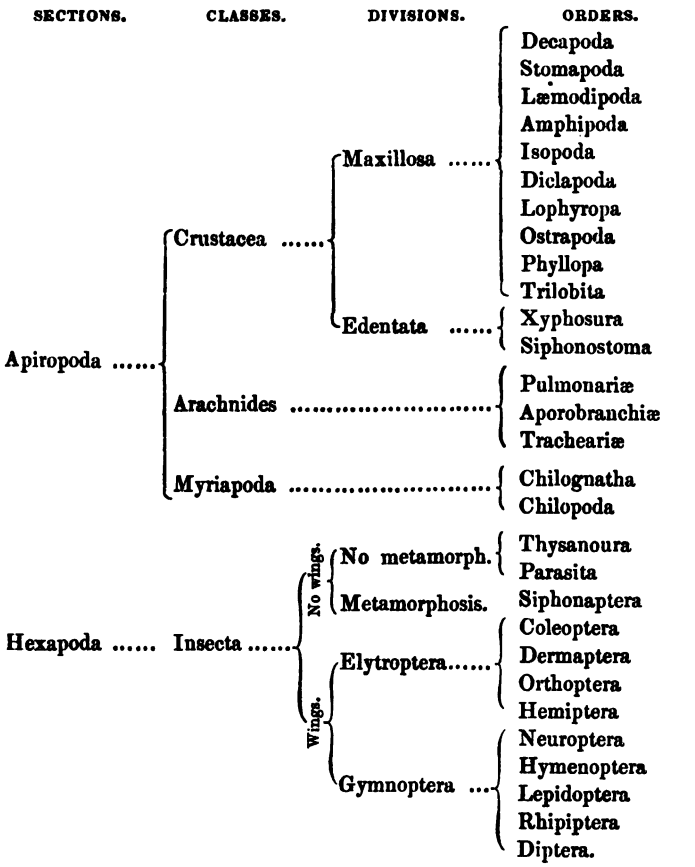
Latreille's last arrangement of insects, as published in the 'Cours d'Entomologie,' is given below.

LATREILLE.



In this brief and rapid sketch of the history of Entomology, I have necessarily omitted the names of many authors, who, though perhaps not introducing any great

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novelties into their systems, have yet, by their brilliant talents and steadfast industry, contributed greatly to advance the science of Entomology. Without attempting even to enumerate these, I must mention a work which has laid the foundation of all that has lately been done in Britain. I allude to Samouelle's 'Useful Compendium.' It is not for me to decide what portion of this work is due to the author whose name it bears, but I must not pass over unnoticed a name occurring in every page,—that of William Elford Leach, a naturalist whose memory is endeared to all who knew him, and will hereafter be regarded with veneration by every student of Entomology while that science has a single votary. Coupled with the name of Leach and British Entomology, I must also mention Mr. Stephens, the author of a complete 'Catalogue of British Insects,' a work exhibiting great talent, research and labour.

The tabular view of Latreille's arrangement, given on the preceding page, may be regarded as an epitome of the science of Entomology as studied at the present day; and, having been published many years subsequently to the labours of Leach, must be considered as incorporating the views of that distinguished naturalist.

From this review of the history of Entomology — which, though confessedly too brief and superficial, displays the opinions of *all* the masters in the science — it will be gathered that a natural group of animals does exist, to which the names of Insecta, Articulata, Annulosa, Condylopoda, &c., have been applied. It now remains for us to enquire into the integrity of this group: on this subject I have entertained many and oft-recurring doubts, and am willing to admit that my opinions have more than once undergone a change.

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The Pterota of Aristotle are a group of animals undergoing metamorphosis after *arriving at their full growth.* Their skin is incrassated and often indurated, affording points of attachment for the muscles, and thus supplying the place of an internal skeleton. Their respiration is performed by tracheæ or air-tubes distributed through the entire body, and communicating with the atmosphere by means of exterior oval apertures arranged along each side. Their circulation is very anomalous: the apparatus for this purpose consists of a series of dorsal hearts opening into each other, and forming a great longitudinal channel throughout the entire length of the body: in this channel a colourless fluid, in which oat-shaped corpuscules are floating, ascends by regular pulsations from the posterior towards the anterior extremity: immediately before reaching the head the main current is discharged right and left, into what appears a general reservoir of the body; its downward and lateral progress may be most readily traced by watching the motion of the corpuscules: in this downward course a portion is received into the great channel by lateral valves, two of which are observable in every segment of the body: before entering these lateral valves the blood seems perfectly unrestricted in its course. The skin or skeleton is transversely divided into segments or rings; these are normally thirteen in number. All the Pterota have six legs, and the representatives of four wings. They are furnished with two antennæ, which, though usually employed as tactors, appear likewise to be the seat of some sense unknown to us. The Pterota are moreover distinguished among the articulates by the entire want of the vegetable power of reproducing limbs which have been accidentally lost.

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The remaining articulates are not thus to be circumscribed: the respiratory and circulating systems are so different in the various component groups, that they cannot be regarded as affording any satisfactory character. They agree with the winged insects in the possession of jointed legs, but differ in possessing also the vegetable power necessary to their reproduction when lost. They have no trace of wings, even in a rudimentary or undeveloped state. They are entirely without adult metamorphosis, for it will be recollected that the metamorphosis — so well known in the young of Myriapoda, and discovered by Mr. Thompson in the young of Crustacea — is what might almost be termed a fœtal metamorphosis, and is rather analogous to that of the young kangaroo than to that of the full grown caterpillar of a moth or butterfly. In strict compliance with scientific truth, metamorphosis is but a mode of that change common to all organized beings, but the mode becomes a character, and constitutes a difference more striking than the introduction of a new series of organs; so that, in this fact alone, there is a barrier erected to the integrity of the articulates as a province.

I have already said that I regard it a test of the equality and natural character of groups, that they shall submit to corresponding subdivision. Now it scarcely admits of a doubt that, if we separate the Pterota, the remaining articulates are divisible into four groups, three of them being identical with Latreille's classes, — Crustacea, Arachnides and Myriapoda,—and the fourth corresponding with the first division of his fourth class, and comprising his Thysanoura and Parasita, being equivalent to the Insecta ametabola of Leach. It is somewhat remarkable that each of these groups is almost invariably divided into

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two, thus giving a total of four double, or eight single classes of apterous articulates. Latreille's triple division of Arachnida is quite unusual, nearly all entomologists agreeing in dividing them into pulmonary and trachean.

The following summary results.—

FOUR CLASSES.		EIGHT CLASSES.
Crustacea	=	Malacostraca Entomostraca
Arachnida	=	Arachnida Acaridea
Myriapoda	=	Chilognatha Chilopoda
Ametabola	=	Thysanura Anoplura.

It remains for the skilful anatomist to show that one of these groups is separated from its fellows by artificial cha racters only. Although I am not sufficiently master of the subject to attempt this, I will venture an opinion that the Crustacea will eventually be recognised as the single, normal, and central group. The contents of this group are peculiarly heterogeneous. The Decapoda are, by all entomologists, considered the normal division of the group. Cyamus and other Læmodipoda approach the genera Nymphon and Pycnogonum among the trachean Arachnida: several of the minute Branchiopoda — as the genus Cyclopsina of Milne Edwards — appear to resemble the Thysanura; and all the Isopoda — perhaps more particularly Oniscus armadillo — seem to approach the chilognathous Myriapoda, more particularly the genus Glomeris. Should these views prove to be correct, Thysanura, Chilognatha and Acaridea will be the subnormal, and Anoplura, Chilopoda and Arachnida the abnormal

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classes of apterous articulates; and their relative position may be shown thus.—

ANOPLURA. THYSANURA. CHILOPODA.

CRUSTACEA.

ACARIDEA. CHILOGNATHA.

ARACHNIDA.

I feel much more confidence in proceeding to the winged insects: these will be found to divide either into four or seven classes, thus.—

AMORPHA;

In which the penultimate state is provided neither with mouth nor organs of locomotion; consequently it neither eats nor moves, nor does it bear any resemblance to the perfect state. This group contains two classes of insects.

Class I. — LEPIDOPTERA; in which the perfect insect has four fully developed wings, all of them covered with a kind of scales, which are symmetrically arranged on each other, like the scales of a fish or the tiles of a house.

Class II. — DIPTERA; in which the perfect insect has two fully developed wings, and two merely rudimentary ones, which are distinguished by the name of halteres or poisers.

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NECROMORPHA;

In which the penultimate state is provided with mouth and organs of locomotion, detached from the body, but so enveloped in a case that it can employ neither. The resemblance therefore to the perfect insect is very considerable, except in the total want of motion. This group contains two classes of insects.

Class III.—HYMENOPTERA; in which the perfect insect has four fully developed wings, all of them transparent or membranous, and without scales.

Class IV. — COLEOPTERA; in which the perfect insect has two fully developed wings, and two wing-cases which cover the wings.

ISOMORPHA;

In which all the states are active and voracious, and of similar form. This group contains two classes of insects.

Class V. — ORTHOPTERA; in which the perfect insect has four wings, the first pair being leathery, of little use in flight, and often very minute and scarcely apparent: the mouth is furnished with two strong mandibles, meeting transversely.

Class VI. — HEMIPTERA; in which the perfect insect has four wings, a portion of the first pair often being leathery: the mouth is a tubular sucker, formed for extracting the sap of plants.

ANISOMORPHA;

In which the amorphous, necromorphous and isomorphous characters appear, together with others not possessed by those groups. This group contains but one class of insects.

Class VII. — NEUROPTERA; in which the perfect insect has four reticulated wings.

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The following summary results.—

FOUR CLASSES.		SEVEN CLASSES.
Amorpha	=	Lepidoptera Diptera
Necromorpha	=	Hymenoptera Coleoptera
Isomorpha	=	Orthoptera Hemiptera
Anisomorpha	=	Neuroptera.

It will perhaps be excusable also to show the correspondence between the proposed somewhat more precise divisions and the earlier divisions of Swammerdam and Lamarck: the correspondence is not quite perfect, owing to the trivial errors already alluded to as having occurred in Swammerdam's classification: a second supposed advantage in the proposed new arrangement, consists in the greater precision and applicability of the names.

SWAMMERDAM.		LAMARCK.		PROPOSED ARRANGEMENT.
Obtected	=	Chrysalis	=	Amorpha
Incomplete	=	Mumia	=	Necromorpha
Semicomplete	=	Nympha	=	Isomorpha.

The varied character of Neuroptera generally, and the normal character of its principal group, the dragon flies, suggest its position as a normal and central class: the group comprising the Linnean genus, Phryganea, both in habit and metamorphosis closely approaches the Lepidoptera: the group comprising the genus Corydalis, &c., in all its states comes very near the Hymenoptera: and the isomorphous Perlina equally approach the Orthoptera. Having

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entered into this subject at so great length in the 'Entomological Magazine,' subjecting the segments, wings and mouth to a rigid investigation and comparison, I shall refrain from further detail. Lepidoptera, Hymenoptera and Orthoptera, appear to be the subnormal, and Diptera, Coleoptera and Hemiptera, the abnormal classes; and the relative position of the seven classes appears to be as under.

HEMIPTERA. LEPIDOPTERA. DIPTERA.

NEUROPTERA.

ORTHOPTERA. HYMENOPTERA,

COLEOPTERA.

By a reference to the celebrated systems of Aristotle, Swammerdam, Linneus, Fabricius, Clairville and Latreille, founded on the wings, metamorphosis, mouth, or a combination of these characters, and a sketch of which has been introduced in the present chapter, it will be seen that the above arrangement of winged insects is in harmonious accordance with them all. In the first place, a comparison with the alary system of Aristotle (p. 91) and Linneus (p. 94), will show that no two classes which these authors placed together are now separated. Secondly, the cibarian or maxillary (p. 96) makes the Hemiptera, Lepidoptera, Diptera, and a portion of the Neuroptera, haustellate; while the remainder of the Neuroptera, together with all the Orthoptera, Hymenoptera and Coleoptera, are mandi-

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bulate; and nothing could coincide more completely with the proposed new arrangement. Thirdly, the metamorphotic system of Swammerdam (p. 93), Ray, Willughby and Lamarck, (reduced to somewhat more precision by the observations at pages 102 and 103), shows that the Lepidoptera, Diptera, and a portion of the Neuroptera, are amorphous; the Hymenoptera, Coleoptera, and a portion of the Neuroptera, necromorphous; and finally, Orthoptera, Hemiptera, and a portion of the Neuroptera, isomorphous; so that, in this instance also, the correspondence with the proposed arrangement is perfect.

In my observations on the classes of Vertebrata, I have called attention to the parallels pointed out by Linneus as existing between tribes of distinct classes, and after suggesting for consideration parallels between placentals and marsupials, and between placentals and birds, I have ventured to express an opinion that groups which bear this test are natural groups. Now supposing the Pterota and Aptera to be provinces equalling the vertebrates in importance, I think it is probable they will submit to similar subdivision; but I must freely confess that I have hitherto failed in discovering any parallels but such as appear rather too hypothetical to be of any real value, still I find no reason to retract or even modify what I have said on this subject: the evident similarity between the reptiles and myriapods indicates the existence of a parallel in this instance at least, and the similarity between fishes and Crustacea suggests the idea of a second parallel; but it is most undesirable to follow out the subject, seeing that in the end we must have recourse to conjecture.

I think it will be admitted by those who have given the subject the consideration it deserves, that the Pterota and

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Aptera very closely approach each other, by means of the Diptera and Anoplura ; so closely indeed, that, in the instance of more than one genus, it is difficult to say to which province it really belongs. This has led to the mixing up of these supposed primary divisions of the animal kingdom, — a mixing up not consequent on carelessness or haste, but the result of deep consideration and cautious induction ; and I must in candour remark, that no author of celebrity, and scarcely one who has attempted a classification, has adopted Aristotle's broad division of Pterota and Aptera. Linneus, Fabricius, Clairville, Cuvier, Latreille, Leach, Kirby and Stephens, dismiss the idea as even unworthy consideration. As it has always been my wish to quote the views of eminent zoologists, by way of corroborating my own, I must admit that this "cloud of witnesses" against me, — men whose opinions I should have quoted as almost presumptive evidence, if in my favour, — throws a doubt over the proposed division of articulates which it is extremely difficult to dissipate.

With respect to the other divisions of the invertebrate animals into Vermes Mollusca and Vermes Annelida, and into Radiata Echinodermata and Radiata Zoophyta, I think that zoologists generally will be inclined to admit such or similar divisions. In the instance of the zoophytes it may, however, become a question for the microscope to decide, whether the Amorphozoa or sponges are not distinct from the other Radiata.

Before closing this chapter, which has already extended to an unreasonable length, it seems desirable to allude for an instant to the supposed fact mentioned at page 26, that the subnormal groups form a series among themselves. These subnormal groups, in the present instance, are the

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mollusks, echinodermes and Crustacea, and the connexion between or among them *seems* much less perfect than it would have been had the position of the mollusks and annelides been reversed, and the echinodermes thus brought more immediately into contact with the latter, as pointed out by many naturalists, by means of the genus Fistularia. But I am not yet aware that the structural resemblance of the Holothuridæ to the annelides is *really* greater than to the mollusks. Giving the group the wider range allowed it under the appellation Nematoneura (of Owen), the Epizoa, especially the species of Lernæa, approach the edentate Crustacea; the Holothuridæ approach the mollusks and annelides; and Comatula, in its adolescent state described as a Pentacrinus, equally approaches the Zoophytes.

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CHAPTER IX.

ON CONCENTRIC CIRCLES AND CONVERGING RADII.

I HAVE endeavoured, in the preceding chapters, to explain my views of the System of Nature by a synthetical grouping of animals: beginning with man as a centre, I have added the various groups of animals around him in a series of rings: these rings amount to eight in number, besides the central area, which I suppose occupied by man and those quadrumanous animals which most nearly approach him; and the exterior groups being limited by a series of concentric circles, each increasing in diameter as the animals, whose limit it circumscribes, are supposed to recede in structure from the normal and central form of man. In accordance with certain defined but unproved propositions, the animals supposed to stand in these eight different degrees of approximation to man are thus enumerated.

Within the first circle are the Cebidæ or American monkeys, the Bradypidæ or sloths, and the Lemuridæ or lemurs; within the second circle, the Galeopithecidæ or flying lemurs, and the Megatheriidæ or fossil sloths: these five groups, with the Hominidæ, as the central group has been termed, constitute the higher group which has been usually

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denominated Primates. A space in the second circle is vacant, and I have suggested the possibility of this eventually being filled by an aquatic animal resembling the monkeys: this idea, however, not resulting from absolute fact, is to be considered as hypothetical, and is not employed as affording any evidence in favour of the propositions hereafter advanced.

Within the third circle are the Glires or rodent animals, the Belluæ or hoofed animals, and the Feræ or beasts of prey; and within the fourth circle are the Cheiroptera or bats, the Bruta or ant-eaters and armadilloes, and the Cete or whales: these six groups, together with the Primates, constitute the class of Placentalia or placental animals.

Within the fifth circle are the Marsupialia or pouched animals, the Cataphracta or tortoises and turtles, and perhaps also the crocodiles, and the Pisces cartilaginei or cartilaginous fishes; and within the sixth circle are the Aves or birds, the Reptilia or lizards, snakes, &c., and the Pisces ossei or bony fishes: these six groups, together with the placental animals, constitute the province of Vertebrata or vertebrated animals.

Within the seventh circle are the Aptera of Aristotle, comprising the Crustacea, spiders, centipedes, &c., the Mollusca or molluscous animals, and the Radiata or true radiate animals, as starfishes, sea-urchins, Medusæ, &c.; and within the eighth or exterior circle are the Pterota of Aristotle or winged insects, the Vermes Annelida or worms, and the Zoophyta and Amorphozoa or zoophytes and sponges: these together constitute that vast and diversified assemblage which zoologists have aptly and emphatically denominated invertebrate animals, and which, together with the Vertebrata, constitute the entire animal kingdom.

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These gradations may be brought into one point of view by a chart, in which the concentric circles are represented by parallel longitudinal lines.

From observations scattered throughout the foregoing chapters, there also results the inference of a principle which I have hitherto forborne to make a prominent or essential feature of the scheme I am endeavouring to develope, lest I should become obscure and create confusion, through my inability to cope with the entire subject; but now that I have accomplished a sketch of my views of the grouping of the animal kingdom, it becomes necessary to explain this supposed principle. I allude to the fact that every natural group appears divisible into four minor groups, three of which are double, and surround the fourth, which is central and single. Examples may be given in the groups whose classification is considered in the previous pages.

The placental animals, (p.13).

Glires*
Cheiroptera
Feræ
Cete
Belluæ
Bruta
Primates.

* The saltant Glires, to use a homely expression, *throw off* the volitant bats: these are flying, fluttering *mice*, not flying bears or flying lions, as they must be if connected with the Feræ. The same acute perception which teaches the most uneducated person to recognise a bird, teaches him also that a bat is a flutter-*mouse*; and, so considered, its situation in a system would be obvious to all: but, when placed by our greatest zoologists either in the Primates or Feræ, a learner must always hesitate before adopting either conclusion. In like manner, the Feræ appear to me very evidently to throw off a great and ponderous group of

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The vertebrate animals, (p. 70).

———	Marsupialia, Aves
Pisces	Cartilaginei, Ossei
———	Cataphracta, Reptilia
Placentalia	

The animal kingdom, (p. 81).

Articulata	Crustacea, Insecta
Radiata	Echinodermata, Zoophyta
Mollusca	Mollusca, Vermes
Vertebrata.	

The Aptera of Aristotle, (p. 102).

Arachnida	Acaridea, Arachnida
Myriapoda	Chilognatha, Chilopoda
Ametabola	Thysanura, Anoplura
Crustacea.	

The Pterota of Aristotle, (p. 105).

Amorpha	Lepidoptera, Diptera
Necromorpha	Hymenoptera, Coleoptera
Isomorpha	Orthoptera, Hemiptera
Anisomorpha	Neuroptera.

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natant animals, which have almost invariably been distinguished by the name of Cete: these are not all rapacious; we have seen that where they approach the Belluæ the contrary is the case: yet, still considering them as a group, we may call them rapacious, since by far the greater number devour living animal food. Lastly, the Belluæ, Pachydermata or Ungulata of authors, throw off the Bruta.

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Although I am unable to adduce instances from the preceding pages in support of such an opinion, I will yet venture to record my firm belief that pairs similar to these occur in all minor divisions. We even find pairs of species: it is a circumstance of frequent occurrence to meet with two species so extremely similar that it requires the instructed eye of science to detect a difference between them.

I now revert to the fourth group, which I have described (p. 111 *et passim*) as 'central and single.' Although this definition may be correct when contrasting it with the obviously double groups by which it is surrounded, yet when submitted to an isolated analysis, this central group will be found again divisable into two portions, one much more extensive and more important than the other. This kind of dichotomy may be represented by what has been called a sesquialterous circle. As examples of these sesquialterous centres, I may cite the Crustacea and Neuroptera: the former comprising the normal Maxillosa and abnormal Edentata, and the latter the normal net-winged Neuroptera and abnormal Phryganeæ; the abnormal groups being so decidedly discrepant, that naturalists have not hesitated to raise them to a rank equal to that of the normal groups, the names Entomostraca and Trichoptera having been applied to them. These instances of sesquialterous centres are not peculiarly striking, but are the only ones occurring in the five groups which have been considered in the preceding pages; the other centres, Primates, Placentalia and Vertebrata, appear single, a peculiarity which I suppose attributable to their centrality as regards the animal kingdom.

This disposition of groups to contain two most unequal yet well-marked divisions, can scarcely have escaped the

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notice of any observant naturalist. It seems to me owing to the combined influence of three distinct principles: 1st, the existence of centres; 2ndly, the existence of parallels; 3rdly, the existence of dichotomous external groups. Taking the Crustacea as an example, I will state a case hypothetically by way of explanation. I will suppose it proved that the vertebrates and apterous articulates each contain four prominent groups, and that they correspond with each other, thus: —

VERTEBRATA.	*APTERA.*
PLACENTALIA.	ARACHNIDA.
AVES.	AMETABOLA.
REPTILIA.	MYRIAPODA.
PISCES.	CRUSTACEA.

I will next assume that fishes are external and double in the vertebrates, and that Crustacea are central and single in the Aptera. In accordance with the theory of parallels, both groups of fishes must find representatives in the Crustacea: we can scarcely imagine this to be accomplished otherwise than in a sesquialterous manner, one portion vastly exceeding the other in importance: thus, the rapacious cartilaginous fishes, being the higher group as regards the class Vertebrata, would find a parallel in the rapacious Maxillosa or Malacostraca; and the abnormal and less rapacious bony fishes would find their parallel in the Edentata or Entomostraca.

Returning from this short and I think necessary digression on the sesquialterous character of certain groups — a phenomenon of almost constant occurrence,—I resume the consideration of the animal kingdom as expressed by a figure of concentric circles. It will be observed that I have already stated my opinion of the groups circumscribed

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by these circles, and have assigned a certain position to each group. As explanatory of this grouping I now offer some general observations on the principles which seem to have been employed more or less directly as accessories.

Animals, on whatever plan constructed, are distinguishable from other forms of matter by the power they possess of moving *sponte suâ* from place to place. Air, earth and water subserve this power of locomotion. Animals are therefore adapted for an aërial, terrestrial, or aquatic life. As man, when constructing engines for moving through the air, on the earth or in the water, invariably adapts each for its respective destination by every artifice and contrivance his ingenuity can devise, so the Divine Architect, with skill how infinitely superior, adapts each of his creatures to the element in which He wills its life shall be passed. So strikingly is this the case, that man is ever ready to adopt, as completely as he may, the forms and the contrivances which he finds employed in the adaptation of the animal frame to the requirings of diversified economy.

Now as there are three very distinct elements—I use the term in its vulgar, not its scientific application — so there appear to be three very distinct concentric radii proceeding from certain points exterior to the animal kingdom, analogous to these three elements, and exercising a direct influence over the groups of animals through which they pass.

Let us suppose a map of the animal kingdom, in which the degree or grade of structure shall be expressed, as already proposed, by a series of concentric rings; and let us imagine, exterior to the outer ring, three equidistant points, supposed to represent the elements, air, earth and water. From each of these points a line may be drawn to the common centre, and these lines or radii, supposed to represent

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respectively the influence of air, earth and water, may be called the aërial radius, the terrestrial radius, and the aquatic radius.

In addition to these three radii, whose influence is due to certain combinations of matter wholly independent of, and quite exterior to, the animal kingdom, there appear to be other three, whose influence is less strongly marked, whose distinguishing characteristics seem much more difficult to define, and whose attributes are entirely animal, and therefore perfectly distinct from any to which names, having reference to combinations of matter apart from animal life, could with propriety be applied. These appear to alternate with the others, and the names which I propose applying to them are these ; — saltant, ambulant and rapacious.

These animal radii are connected with the concentric radii in pairs, thus :—the aërial and saltant ; the terrestrial and ambulant ; the aquatic and rapacious. The pairs of groups to which their influence extends are already noticed, and will again be brought under review.

It has been said that the concentric circles indicate degrees of structure : together they form a graduated scale of which man is the summit : in estimating the position of any group on this scale, the terms superior and inferior are liable to misapplication : the grade to which any animal is entitled must not depend on our opinion of its perfection or imperfection, but on its approach to, or departure from, the normal form of man. The radii, on the contrary, are the indices to economy. On the correct appreciation of these characters — structure and economy — depends the whole secret of natural classification. From overlooking or undervaluing these distinct sources of difference, and thus

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confusing the results of their combination, has arisen the hypothesis known as the theory of *affinities* and *analogies*. Not only are these terms objectionable as conveying to the mind no definite idea, but, as they are employed by naturalists, they are wholly devoid of *fixed* meaning, because capable of bearing *any* meaning: it having always been regarded as optional with a systematist, whether he should consider any given resemblance a relation of affinity or one of analogy. The System of Nature has but two sources of character,—structure and economy; these are definite; and it need scarcely be asserted that the former is ever modified in accordance with the requirings of the latter.

Let us commence our examination of the radii with the one which I have termed aërial. Tracing the course of each radius through a series of circles, whose contents have already been detailed and their relative positions laid down, necessarily involves considerable repetition, but such repetition appears preferable to the obscurity attendant on a too hasty dismissal of this branch of the enquiry. I need scarcely remind my readers, that as three out of every six groups are supposed to recede from the centre farther than the other three, and consequently occupy places in another circle, a direct line drawn from the circumference to the centre can only intersect groups situate in alternate rings: thus the aërial radius passes through four groups instead of eight; these are the province Pterota, the class Aves, the tribe Cheiroptera and the order or family Galeopithecidæ.* It will at once be seen that the radius in question, as it intersects each of these groups, commu-

* I find all our most able zoologists insist on placing the flying lemur (Galeopithecus) among the Primates; and I avail myself of this opinion in preference to my own adopted from Cuvier.

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nicates to its contents a volitant character; and this character, it must be observed, is due to the propensity or economy, and in no degree to structure, which seems to suffer any modification consistent with the retention of its own distinctness, in order to meet the requirings of this aërial influence. With regard to the intensity of the influence of this radius, it has four well-marked divisions or degrees; its tendency being always the same, to incite the animal to aërial progression, and supply the means required for the gratification of this propensity: in fact, to furnish the animal with "wings," the metaphorical character of which word has been already pointed out, (p. 83).

In the Pterota or winged insects the structure is articulate, the number of legs is six, and throughout the province these are in no instance transmuted into organs of flight: but there are other parts especially supplied as organs of flight; these are developed from the dorsal surface of the third and fourth segments, and are universally known by the name of wings. The wings of the Pterota are peculiar to this province of the animal kingdom, and are unique as organs applicable only to the purpose of flight: winged insects must therefore be considered as influenced by the aërial radius in the first or highest degree. As it will be quite impossible, within the compass of an essay like the present, to analyse each group considered as a system in miniature, it may not be amiss to remark in passing, that this volitant character appears normal in the normal and central class Neuroptera, many of the more conspicuous insects of the class spending the day-time of their lives entirely on the wing.

In birds the structure is vertebrate; the limbs or organs of locomotion being four: the anterior pair are furnished

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with feathers, so constructed as to form efficient implements of flight: birds therefore are influenced by the aërial radius in a less degree than insects, being indebted for the power of flight to the transmutation of an organ normally provided for a very different employ. The swallows among birds, like the dragonflies among insects, spend their lives, except during repose, entirely on the wing: the acts of eating, drinking, and even of copulation, are performed in the air.

In bats the structure is not only vertebrate, but the generation placental; and the limbs retain very nearly their normal character, the component bones of the foot and hand being almost identical with our own; but the fingers are lengthened, and connected by a delicate membrane, which extends to the hind legs and tail, forming a most complete and powerful organ of flight. These animals must be considered as less under the influence of the aërial radius than birds, because their limbs exhibit less deviation from the normal structure. The normal bats seek their food entirely on the wing.

In the flying lemur (Galeopithecus) it is most interesting to trace the influence of the aërial radius, carried, although in its last or weakest degree, into the very central group of the animal kingdom. Every consideration derived from structure or economy must place this strange creature at that point of the group Primates which most closely approximates to the bats, and therefore at the very place traversed by the aërial radius in its direct progress towards the centre of the system. I believe this singular genus stands perfectly isolated, as far as our present knowledge extends: it is characterized, like the flying squirrels and phalangers, by a quantity of loose skin appended to

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its sides, and connecting the fore and hind legs, behind which it is also continued to the tail. When it is desirous of passing from tree to tree, it spreads its legs as widely as possible, and this skin is thus distended to the utmost; so that the animal is converted into a kind of parachute, sailing slowly downwards or with the wind, and protected from any risk of injury from falling by this admirable provision: the influence of the aërial ray is here exhibited in its fourth and last degree. It need scarcely be mentioned to the naturalist, that a number of peculiarities in addition to wings are incident to the power of flying; of these increased respiration is one of great importance, and the absence or lightness of bones is perhaps scarcely inferior.

We now come to a radius of a very different character: it is indissolubly linked with the aërial, yet scarcely in any degree partakes of its distinguishing attribute: its proposed name of *saltant* is not presumed to be perfect, or to express a character that is dominant throughout its course. The groups traversed by this radius are these: the province Aptera, the class Marsupialia, the tribe Glires, and the order or family Lemuridæ: it need scarcely be added that these are twin groups to Pterota, Aves, Cheiroptera and Galeopithecidæ, traversed by the aërial ray.

If we abstract these pairs of groups from the general system, and suppose each pair to constitute a system of its own, we shall find considerable difficulty in deciding to which of each pair precedence or superiority is to be assigned. Were we to insist on the superiority of the saltant radius, we should say that Galeopithecus is nothing more than an abnormal or flying lemur, that a bat is only a flying mouse, a bird only a flying marsupial, and a bee only a flying articulate: but were we to insist on the value of

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the aërial character, we should readily find expressions and apparent reasons for degrading the saltant; the Aptera would be insects deprived of their distinctive character—the power of flight, marsupials would be little better than reptiles, or birds without wings; mice might be called bats without wings, and lemurs only a degree above sloths.—This facility in assuming the superior importance of any given character, has led to very many tedious and unprofitable discussions. The respective claims to precedence of a bee and a mollusk have been sharply contested, and the complicated articulate structure and surpassing instinct of the former urged in its behalf. Instinct is not reason. Let instinct and the perfection of articulate structure be expressed by *z*, and let reason and the perfection of vertebrate structure be expressed by *a:* the bee will stand no chance of advancing even by a single letter nearer to man, while the cuttle-fish might reasonably claim an intermediate place. This difficulty is but another proof of the error of laying down certain characters as of paramount importance, and then making all others yield to them.

The terrestrial radius ascends through the province Vermes or Annelida, the class Reptilia, the tribe Bruta, and probably the order or family of Megatheriidæ, or fossil sloths; and its companion radius, the ambulant, traverses the province Mollusca, the class Cataphracta, the tribe Belluæ, and the order or family of Bradypidæ, or recent sloths. In the first of these, the reptile character of crawling or creeping on the ground is predominant throughout, but, like the aërial, it has four degrees or grades. The worms are without legs, and habitually reside in the earth; the snakes and lizards creep on the earth, the latter have legs, but so short in comparison to their body, and the

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pairs so far apart, that they always crawl on their bellies in the same manner as snakes; the armadilloes and ant-eaters are the third grade or step, and in them the reptile gait is still preserved, although perhaps less conspicuously; to the gait and economy of the fourth group, the giant fossil sloths, we have but a slender guide in the scattered remnants now in existence.

The distinguishing characters of the ambulant radius, like those of the saltant, are difficult to define with precision; and I trust to the intelligence of zoologists in tracing the peculiarities, all unimportant though they may seem, which obviously distinguish it, rather than resort to others which might require hypothesis to support them. These obvious characters are lethargy, sloth, vegetable food, insensibility to pain, tenacity of life, thickness of covering, and others nearly analogous. The series commences with the shell-bearing mollusks, then goes on to the tortoises, then to the Belluæ, and lastly to the sloths.

The aquatic radius ascends through the province Zoophyta, the class Pisces Ossei, the tribe Cete, and is supposed to enter the Primates by means of some aquatic animal at present unknown. Its companion radius, the rapacious, ascends through the province Radiata, the class Pisces Cartilaginei, the tribe Feræ, and the order or family of Cebidæ or American monkeys. In this instance the characters of both rays are perfectly defined, perhaps even more strikingly than in the preceding instances, until we enter the Primates, where they appear lost. Surely it is unnecessary to dwell on characters so obvious: if the aquatic character be not evident on the mere mention of zoophytes, fishes and whales, it cannot be enforced by any arguments of mine.

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I can scarcely imagine a zoologist coolly investigating the propositions contained in this chapter, and expressing a dissentient opinion as to their *general* accordance with nature. In the detail he may detect a flaw: he may disapprove of the station occupied by the sloth or the Megatherium: he may prefer the usual dichotomous division of the reptiles to the one which I have suggested: he may contend for the transposition of the mollusks and annelides in order to accommodate the resemblances to which I have already alluded: still the scheme will remain untouched; still will the truth, the beauty, the simplicity of the arrangement remain unimpaired. I trust to that truth, beauty and simplicity as sufficient evidence that it is not of human invention. That I should fail in carrying out much of the detail, is not only an inevitable result of my insufficient knowledge of Zoology, but is a result to be anticipated from the insufficiency of *all* human intellect to deal with questions of such boundless magnitude. In this sketch of a system showing characters grouped in circles or radiating in lines, yet ever harmoniously blending with each other, I cannot but hope the zoologist will admit the existence of a design superior to chance, of a perfection and entirety distinct from the speculations of man.

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CHAPTER X

ON THE UNITY OF THE SYSTEM OF NATURE.

THE modern naturalist, eschewing the atheistical doctrine of spontaneous generation, assigns to every organized being a parentage or a Creator. Parentage is regarded as the immediate source of organic existence, and may often be traced for several successive generations: even when lost to our means of enquiry, it needs no stretch of the imagination to suppose parentage extending backwards into the past for an indefinite number of years. We thus postpone but cannot dissipate the necessity for a Creator. The first parent or parents must have received existence at the hands of God. A question therefore arises—a question to which the reply must be in the negative — was the animal kingdom the instantaneous result of a single mandate of the Almighty?

Until lately, the zoologist dealt only with forms that were moving and breathing around him; but now the sister science of Geology has opened another avenue to knowledge, an avenue that conducts him through countless ages of the past. This wonderful science has unsealed a book of facts far more extraordinary than the fictions of the most brilliant imagination. From Geology we learn that

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the earth is covered by numerous layers of stratified rocks, reposing one on the other in an order strictly according with the eras of their deposition. As far as research has hitherto extended, the lowermost of these layers or strata contain no remains of organized life: hence it appears that during the process of their deposition, a period extending perhaps to innumerable ages, the Creator had not peopled the earth with living inhabitants. Almost every one of the remaining strata contains the relics of certain animals absent from the strata next in succession both above and below it: and from this circumstance, combined with a consideration of the time required for the deposition of each stratum, the inference has been fairly drawn, that living beings have been called into existence, and have become utterly extinct, at a great number of periods so remote from each other, that we can find no available key to the mensuration of intervening time. Hence we learn that our former knowledge of Zoology, instead of making any claims to be considered as general, was confined to a portion of a series perpetually changing—was in fact restricted to the instant of time serving to couple the future with the past.

It becomes a matter of intense interest to the zoologist to compare the forms composing these preadamite creations with those which are still moving around and among us, synchronous in creation and existence with our own. It has been the peculiar object of the geologist to make this comparison: to search laboriously into the sublime records of the past: to reconstruct perfect frames from bones or shells, and even from their fragments, when broken, crushed, and widely separated from each other: to clothe the frames with muscle and endow them with life—

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to predicate their propensities, their food, their economy; to arrange each in accordance with these results, and thus prepare himself for the question, whether these successive creations afford types or examples of many systems, or are but portions of one system, and *that* a system which has not yet passed away? I have no hesitation in saying that the latter is the case.

We have seen that the animals known to us in a living state are constructed on certain plans, the more marked of which have been termed vertebrate, radiate, mollusk and articulate; but other plans have been noticed, and indeed have been supposed by some naturalists quite equal in importance to what may be termed the Cuvierian groups above enumerated. The number of primary divisions has been variously stated as two, three, four, five, six, seven and eight: all these groups are framed with a reference to natural characters.* Now among all the extinct animals there is but one family that is not directly referrible to one or other of these groups. With this single exception — I allude to the trilobites — every fragment finds its place in some well-marked division, the representatives of which are still in the full enjoyment of life and happiness. Goldfuss and Latreille describe the trilobites as having been furnished with legs; and the latter, without any hesitation, constitutes an order of Crustacea purposely to receive them. This question of their possessing legs is one concerning which doubts have been entertained; but the conclusion as to their place in the system seems to be perfectly

* Perhaps excepting the numbers three and five: the advocates of these numbers are, as it were, "horsed on an idea," and their divisions on this account scarcely deserve the same credit as the rest.

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satisfactory. The compound eye possessed by a trilobite is only known amongst the articulates.

It appears also worthy of especial remark, that animals of all the structures, even the highest or vertebrate, existed anterior to the deposition of the greater portion of the first or earliest series of stratified rocks; and, therefore, that the improvements which have taken place during successive milleniums, evince improvements on certain plans in existence from the first, rather than the introduction of other plans, and seem always to have been attendant on corresponding improvements in the surface of the earth.

In the beginning "the earth was without form and void, and darkness was upon the face of the deep." The earth was a chaotic mass of those unstratified rocks which disclose to the geologist no trace of life. The first fiat of creation appears to be contained in the emphatic words — "Let there be light!" The earth being divided into land and water, furnished with light, and thus fitted for the reception of animals and plants, the creative fiat again went forth, and the land was covered with vegetables and the water swarmed with animals: among the former, botanists find a preponderance of cryptogamic vegetation; among the latter we have zoophytes, bivalve shells and other mollusks, trilobites, and fishes of both classes, the osseous and cartilaginous. These appear the result of many creations, or perhaps a single act of creation continuing through unnumbered years. It will doubtless occur to the reader, that these creations of the transition series very nearly correspond with the groups of animals which I have supposed to be under the influence of an aquatic or natant radius.

During the next great geological period, termed the secondary series of stratified rocks, the earth was adapted

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for the reception of animals. It is not for us to say by what means this change was effected, but doubtless an atmosphere adapted to aërial respiration was one of the most essential changes: the creations of the former period were composed of animals capable of breathing water, but now another element was provided for this purpose. The almighty fiat again went forth, and the earth was peopled with reptiles. This seems to have been the era of monsters: the vast Iguanodon, and those anomalous forms the Mosasaurus, Plesiosaurus and Ichthyosaurus, seem to have enjoyed uninterrupted dominion; and what appears a striking character of the age is, that its herbivora were of the reptile class. The Iguanodon himself probably devoured the tropical foliage that grew in rank abundance around his haunts. His bulk, or the thickness of his skin, might well protect him from attack; but, like the rhinoceros, he was furnished with a nasal horn, that must have proved a formidable weapon when wielded with a power so prodigious. Synchronous with these huge reptiles were the earlier marsupials — the opossums and pterodactyles. The creations of this epoch seem to fall principally on the terrestrial radius, but by no means to be exclusively terrestrial: not only were many of the reptiles, as Mosasaurus &c., wholly aquatic, but there were abundance of species added to the radiates, mollusks, articulates and fishes; and the pterodactyles were creatures furnished with long and powerful wings, well adapted for making their way through a damp and murky atmosphere.

Lastly, during the deposition of the tertiary strata, a period further subdivided by Lyell, there was a purification of the atmosphere, and an intensity given to the light.— Coloured flowers adorned the trees, and were strewn upon

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the ground: butterflies and birds wandered through the air, and the earth was peopled with placental animals. Thus it appears the first series of creations were normally fishes, the second normally reptiles, and the third normally birds, respectively representing the three great radii of economy. After all these was that great and last creation of all, of which man was the object and the masterpiece. "God created man in his own image; in the image of God created he him;" and man was not called into existence alone: together with him were created myriads of those bright and beautiful creatures now inhabiting the earth, and whose remains, like those of man, have yet to become the property of the geologist.

Let it not be supposed that I quote the emphatic language of the scriptures except as beautifully appropriate to the subject. That Book treats not of Science. It has always appeared to me that those geologists who plead the cause of the Bible have done more harm than good by their sophistries — their weak attempts to prove a coincidence between what is written and what is seen; and that they open a wider field for doubt by inventing hypotheses so easy of disproof. In these cases, I believe what I read in the Bible and what I see with my eyes; and if the results do not always agree so well as I could wish, I seek not to pervert or twist a meaning on the one hand, or disguise a fact on the other, for the sake of proving a correspondence between the two; but humbly and devoutly trust that whenever time may open to us the Book of Nature, we shall find its pages in perfect accordance with those of the Book of Truth.

Each series of creations may comprise thousands of years; the aggregate amount of time being so vast that

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we are lost in endeavouring to form any definite idea respecting it: yet from the instant the Creator first willed the organization and vivification of matter there has been no material change in structural condition. The fossil shell imbedded in the slates of Snowdon, — probably one of the earliest forms of organized matter,—is structurally almost identical with thousands of bivalves, whose inhabitants are even now in full possession of all the pleasures their station in the universe permits them to enjoy. The fishes that fed on these mollusks had bones and muscles, and scales and gills, similar to those of our fishes. The sharks that devoured those fishes were constructed like the sharks now so dreaded by our mariners. Even in those anomalous beings, the trilobites, ammonites and pterodactyles, the difficulties arise rather out of the resemblance than the discrepancy. In the pterodactyle, almost every bone is obviously identical with those in the human frame; and if a doubt still hangs over its class, — if one zoologist considers it a bat, a second a bird, a third — the greatest of all — a lizard, and if the writer of these pages ventures to suggest that it might have been a marsupial, surely the inference to be drawn from this contrariety of opinion is, that the skeleton of these seemingly dissimilar beings is formed on one plan; and, as each party claims the pterodactyle as appertaining to a section of this plan, it is a fair and obvious inference that the creature must belong to the plan itself.

I cannot for a moment suppose that each creation was a system, and that the relics of departed ages are records of systems now no more. I cannot disconnect the present from the past. I believe in one only system, and that the trilobites, ammonites and pterodactyles are not simply

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compatible with that system, but essential to its completeness. I feel no disposition to say of these that they interrupt the regularity of a series or disturb natural affinities. So confidently do I believe in the integrity and unity of the System of Nature, that I regard every anomalous form, whether recent or extinct, as a guide to some part before apparently obscure.

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CHAPTER XI.

CONCLUDING OBSERVATIONS.

Before taking the last step, before alluding to the existence of a group more comprehensive than that of animals, it may be well to state that I am perfectly aware how dangerous is the ground on which I am about to tread. Hitherto my conclusions have been drawn from facts within the reach of every enquirer, but now the speculative must be largely mingled with the demonstrable, and the suggestions must bear the character of hypotheses. Under these circumstances I would fain appeal to the candour of my readers, and, however different their views of this general system may be from mine, I solicit them to consider that the question at issue will be merely between one hypothesis and another, and that arguments, which in their opinion may prove my hypothesis to be unsound, cannot shake the stability of anterior conclusions deduced solely from phenomena.

Although I feel perfectly convinced that the animal kingdom is but a portion of some other assemblage still more vast,—although I feel assured that no argument will ever be adduced to alter this conviction,—yet when I seek to ascertain the exact contents of that assemblage, and

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the position of those contents, *inter se*, I find I am proposing problems which the more I contemplate the more I feel the improbability of my ever being able to solve.

Carus, who seems one of the most profound and original thinkers on these abstruse subjects, appears to consider that universal nature consists of two organized groups, — animals and vegetables; two geological groups, — earth and water; and two atmospherical groups, — gas and vapour. Without pretending to appreciate this division, and consequently without assuming that I can enforce or defend it, still I must acknowledge that I consider it worthy of mature consideration, not only as comprehending all the forms of matter perceptible to our senses, but as excluding such speculative additions as time, space, light, heat and motion, which clearly do not fall within the compass of our enquiry. The existence of such groups as those enumerated by Carus, proves the existence of an aggregate group, of which these are the component parts: and as animals form a portion of that aggregate group, the disposition of its component parts may be in some measure predicated by a comparison with those of the animal kingdom, which, as we have seen, appear to be so many epitomes of the whole.

Returning, therefore, to the animal kingdom, we find on our first attempt to analyse its contents, that the great dichotomy or division into vertebrate and invertebrate, forces itself on our notice. The primary divisions of invertebrate animals, the articulate, mollusk and radiate, may, perhaps, be of somewhat unequal value, but if contrasted with the vertebrate, this slight discrepancy among them sinks into nothing before the vast discrepancy between vertebrate and invertebrate. Again, it must be observed, that each of the invertebrate groups is double, and divisible into

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what I have called a subnormal and abnormal portion. Now, if from the six groups previously enumerated as comprising a general system, we seek to select one eminently superior to the rest, our choice must fall upon animals: of this I can entertain no shadow of doubt. But no sooner have we arrived at this conclusion—no sooner have we placed animals in the centre, than we find vegetables—the next group in importance—reduced to an isolated position on the circumference. I say *isolated*, because it were inconsistent with analogy to suppose the vegetable kingdom double, after treating the animal as single. Moreover, if we test the integrity of vegetables as a group, by a comparison with animals, on the principle of parallels, we find that it would be impossible to treat them otherwise than as a single group. The subject of parallels between animals and vegetables has been fully discussed by writers of high authority; and unqualified as I feel myself to offer an opinion on the subject, I yet venture to subjoin the parallels which have been admitted as existing in Nature.

Vertebrata	=	Dicotyledons
Articulata	=	Monocotyledons
Radiata	=	Fungi, Algæ, Hepaticæ
Mollusca	=	Filices, Equiseta, Musci.

The existence of these parallels, considered as an abstract fact, by no means militates against the central position of animals: we have already seen the placental and marsupial vertebrates presenting similar parallels, although the former of these is central and the latter external; but then the birds form a twin group to the marsupials, uniting with them by gradations almost imperceptible. Now as there is no third group of material organized beings, the

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twin group to vegetables exists only in animals. By this train of reasoning, I think we are led to the conclusion that neither animals nor vegetables constitute a single group complete in itself, but that together they constitute a double group. Thus it seems we have no choice but to abandon the idea that animals occupy the centre of the system. Superior as they certainly are to vegetables, and still more so to unorganized matter in any of its forms, we require for a centre something that shall evince an unquestionable superiority over all alike, a superiority typified by that of vertebrates over invertebrates, yet still more complete, even as the whole must be greater than a part. It has been seen that man is treated as a portion of the animal kingdom, the type and centre certainly, yet still a portion. It will be impossible to find any material being making the slightest approach to him in intellectual capacity, the most unerring test of superiority. The centre of all, the centre of centres, must therefore be immaterial. Apart from religion, and regarded as an abstract question, we can form no idea of such a centre. Our senses take no cognizance of it. Our language cannot describe it. Still, whatever that centre may be, we cannot refuse to admit the probability, the more than possibility, that its attributes are reflected or represented, albeit faintly, either in the material body or immaterial soul of man as the type and centre of the most important primary division; as the most perfect, most intellectual, and most spiritual among created beings.

Again, we must admit that as the three pairs of groups, the organized, the mineral, and the atmospherical, contain all the *created* beings of which our senses take cognizance, so the central and normal must be *increate*, self-existent,

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and eternal. Attributes like these are due only to the Creator. Thus am I led to the belief that the great centre of all is occupied by God; and that His protecting influence, His upholding power, His life-giving presence, radiates from the centre even to the uttermost parts of His boundless and wondrous creation.

The feeble intellect of man is lost in attempts to realize an idea of the infinite majesty thus implied. The globe which we inhabit is but one of several, attendant on a single sun. Our sun is one of millions. Let the imagination surround each sun with attendant orbs; clothe each orb with verdure; people it with life; then recollect there is but one Creator, and He, the Creator of every sun, of every attendant world, of every inhabitant of those worlds, of every system of inhabitants, the Author, and ever-present upholder of one and all. We abandon the attempt to understand attributes so superior to our own.

Should it occur to any reader to enquire how such a Being, clad in omnipotence, present in all space, existent through all time, can be reflected or represented, however dimly, in the figure or intellect of one, dependent on His pleasure for the breath of life, I will reply by another enquiry; I will ask, has He not said it? has He not proclaimed in words whose lustre time cannot dim, whose truth sophistry cannot impair, "God created man in his own image, in the image of God created he him?"

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SUPPLEMENTARY NOTES.

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SUPPLEMENTARY NOTES.

No. 1.

Page 10, line 11.—"*The removal of the Sloth from the Bruta to the Primates.*"

I HAVE omitted to mention that both Linneus and M. de Blainville place the sloth with the Primates: the opinion of Linneus, founded on its pectoral mammæ, is only valuable as far as that character is concerned; while the testimony of De Blainville, accompanied as it is by a flood of evidence, founded on the careful investigations of that most able comparative anatomist, is most important evidence in favor of the view I have taken. De Blainville's opinion on this subject was published in his 'Prodrome d'une Nouvelle Zooclassie,' in 1816, and republished in his 'Ostéographie,' in 1840. It is cited by Professor Owen, in his description of Mylodon,* "Ce sont des Primates:—Par l'état complet de l'avant-bras; la rotondité de la tête du radius; la mobilité du carpe sur l'avant-bras. Par l'état également complet de la jambe dans ses deux os; la grand mobilité du tarse sur les os de la jambe. Par la forme générale du tronc, presque sans queue, large et déprimé plutôt que comprimé à la poitrine:—par la largeur du bassein."—'*Ostéographie de Paresseux*,' 4to. p. 58. That Professor Owen, while admitting the validity of these characters, denies the inference De Blainville has drawn from them, will be seen on a reference to Note 3.

* Description of the Skeleton of an extinct gigantic Sloth. By RICHARD OWEN, F.R.S. &c. London: Van Voorst. 1842.

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No. 2.

Page 11, line 32. — "*Sowewhat corresponding to the Primates of Linneus.*"

We are sadly in want of a more definite nomenclature: the group which throughout I have termed Primates, differs from the Primates of Linneus in excluding the elephants and bats: it also differs from the Quadrumana of Cuvier in including the sloths and man. Seeing that the group as now composed has not received a name, I would propose calling its contents *manupedine* animals, in allusion to what appears a well-marked character, namely, great power of climbing or grasping consequent on the transmutation of one or both pairs of locomotive organs into what may be properly termed hands. The other divisions of placentals would be more aptly termed ferine, cetine, glirine &c., than distinguished as at present by simple plurals; for instance, the term Glires merely implies that there are more dormice than one, but if we say glirine animals, we rather imply animals of the dormouse tribe. The Linnean terms thus slightly modified might still be retained. The Greek compound, Cheiroptera of Cuvier, used to designate the only group not acknowledged by Linneus, might be exchanged for Vespertilionina, a word very aptly expressive although somewhat too long. The tribes of placentals would then stand thus: — Manupedina, Glirina, Vespertilionina, Ferina, Cetina, Belluina, Brutina. I merely suggest these remarks for consideration.

No. 3.

Page 15, line 17.—"*I should rather fancy him a sloth in all his characters.*"

"It would border on the ridiculous," says Professor Owen,* "to advocate the claims of the Mylodon to the Quadrumanous order, because

* Description &c. of Mylodon, p. 164.

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its thorax was wide rather than deep, its muzzle broad and truncated, its pelvis expanded, the head of the radius round and apt for rotation, the inflection of the carpus and tarsus free, the long claws prehensile, and the diet exclusively vegetable. *Yet the claims of the Megatherians to be associated with the Apes and Lemurs are on these grounds equal with those of the sloths.*" Into this brief but valuable passage Professor Owen has crowded all those structural characters which seem to me to lead to the conclusion at which I had previously arrived in the passage above cited, that the Megatherium was a sloth in all his characters. Whether it really does border on the ridiculous to assign weight to such an aggregate of structural similarity, and to express the resemblance by placing apes, lemurs, sloths and megatheriums in the proximity of each other, I must leave to the judgment of my readers. It is scarcely necessary to say that the whole tenor of Professor Owen's work goes to establish the Megatheriidæ as sloths, by a series of the most elaborate comparisons.

No. 4

Page 15, line 25.—" *Inconsistent as it may appear to suppose any approach from the little monkey-like sloth to the giant elephant, these almost equally giant Megatheria will render the connexion more probable.*"

It appears, from Professor Owen's description, that the hind foot of Mylodon was tetradactyle, the two inner toes being furnished with claws, the two outer toes with hoofs. This seems plainly to indicate that these huge creatures were, in their structure, intermediate between existing sloths and existing Belluæ.

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No. 5.

Page 16, line 3.—" *The Megatherium was endowed with strength sufficient to uproot the giants of the forest with his tremendous claws.*" *

"If the foregoing physiological interpretation of the osseous framework of the gigantic extinct sloths be the true one, they may be supposed to have commenced the process of prostrating the chosen tree, by scratching away the soil from the roots; for which office we find in the Mylodon the modern scansorial fore foot of the sloth modified after the type of that of the partially fossorial ant-eater. The compressed or subcompressed form of the claws, which detracts from their power as burrowing instruments, adds to their fitness for penetrating the interspaces of the roots, for exposing and liberating them from the attached soil. This operation having been duly effected by the alternate action of the fore feet, aided probably by the unguiculate digits of the hind feet, the long and curved fore claws, which are habitually flexed and fettered in the movements of extension, would next be applied to the opposite sides of the loosened trunk of the tree: and now the Mylodon would derive the full advantage of those modifications of its fore feet by which it resembles the Bradypus; the correspondence in the structure of the prehensile instruments of the existing and extinct sloths extending as far as was compatible with the different degrees of resistence to be overcome. In the small climbing sloth the claws are long and slender, having only to bear the weight of the animal's light body, which is approximated by the action of the muscles towards the grasped branch as to a fixed point. The stouter proportions of the prehensile hooks in the Mylodon accord with the harder task of overcoming the resistance of the part seized, and bringing it down to the body. For the long and slender brachial and antebrachial bones of the climbing sloth, we find substituted in its gigantic predecessor a humerus, radius, and ulna of more robust proportions — of such proportions, indeed, in the Mylodon robustus, as are unequalled in any other

* The first part of this essay, consisting of 64 pages, was published in November, 1842, and anterior to Professor Owen's work.

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known existing or extinct animal. The tree being thus partly undermined and firmly grappled with, the muscles of the trunk, the pelvis and hind limbs, animated by the nervous influence of the unusually large spinal cord, would combine their forces with those of the anterior members in the efforts at prostration. And now let us picture to ourselves the massive frame of the Megatherium convulsed with the mighty wrestling, every vibrating fibre reacting upon its bony attachment with a force which the sharp and strong crests and apophyses loudly bespeak: — extraordinary must have been the strength and proportions of that tree, which, rocked to and fro, to right and left, in such an embrace, could long withstand the efforts of its ponderous assailant." *

No. 6.

Page 37, line 1. — "*Whether that remarkable extinct animal, the Pterodactylus, was not a marsupial rather than a reptile.*"

It should be observed that the idea of treating the pterodactyles as mammalious rather than oviparous animals, is by no means new, since a learned professor long ago very strenuously insisted on such a classification. I believe however I am the first to rank them as marsupials. I offer a few additional words on this subject, merely with a view to show that the question is still an open one, and not so conclusively settled as Cuvier would lead us to believe, when, after his elaborate and most beautiful analysis, he concludes that the pterodactyle, "from its teeth to the extremities of its toes, is altogether a lizard." I am aware how dangerous it is to offer even a doubt as to a Cuvierian assertion: but I recollect that Peter Collinson, a very humble lover of science, differed from the great Linneus on a question where Linneus was as strong as Cuvier is on pterodactyles. "Your reputation," says Peter in addressing the Doctor,

* Owen, loc. cit. p. 147.

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"Your reputation is so high in the opinion of the learned and curious of this age, that what you assert is taken and allowed to be a real fact: for when I have been reasoning on the improbability of swallows living under water, it has been replied,—'Dr. Linnæus says so, and will you dispute his veracity?'" * Now there are few of us at the present day but think Peter right and the Doctor wrong: so that it is not quite conclusive when I am told "Cuvier says so, and will you dispute his veracity?" I am little inclined to yield to any one in my admiration of our great master and teacher in Zoology, but I refuse to adopt the opinions of any man, merely because they were his; and therefore I wish to show that like the Linnean arguments for submersion as regards swallows, the saurian theory, as regards pterodactyles, may admit of further enquiry.

Dr. Buckland, in his 'Bridgwater Treatise,' has given a most admirable summary of the arguments used by Cuvier on this occasion, and has interspersed them with most important and valuable remarks of his own. Dr. Buckland's universal reputation is a sufficient guarantee for the excellence of this elaborate comparison of the structure of lizards and pterodactyles, and I generally find it quoted in preference to the 'Ossemens Fossiles,' first, because Dr. Buckland's knowledge of the species of pterodactyles is the more extensive of the two, and secondly, because his admirable volumes are so much more accessible than the ponderous and costly tomes of the French anatomist.

It appears from both authorities that the strong and conclusive point — that against which there is no possibility of appeal, is the numerical correspondence of the joints, both in the fingers and toes. After a minute comparison of the joints, illustrated by some very beautiful figures, Dr. Buckland concludes this branch of the enquiry with these words. "All these coincidences of number and proportion can only have originated in a premeditated adaptation of each part to its peculiar office; they teach us to arrange an extinct animal under an existing family of reptiles," &c. It is well known to zoologists that although the number of fingers and toes is frequently five, yet it often varies to a less number, as four, three and two, and even one: on numerical differences of this sort the greatest stress has always been laid; the presence or absence of a finger or toe has always been, and always must be, considered a matter of the

* Linn. Corr. i. 54.

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greatest importance; and when one or two are missing, or are increased or reduced in size, the greatest care is required in discovering which of them has undergone the change. Bearing this in mind, let us count the fingers and toes themselves before we descend to the joints, and we shall see that *the pterodactyles have no more than four, and the lizards no less than five.* The fact of this discrepancy was well known to Dr. Buckland, who supposes that the fifth, or little finger and little toe, are the members that are missing. We are quite without proof on this subject; but supposing the thumb and great toe to be the missing members, which from the distance, detached appearance, and occasional absence of the thumb, is highly probable, then I think it will appear that the so-called thumb becomes the first finger, the so-called great toe becomes the second toe, and so on with all the rest; and thus the numerical correspondence in the joints will require revision. Again, I must confess that since we possess such an admirable figure of Pterodactylus crassirostris, (a figure accurately copied into Dr. Buckland's work), I should have preferred an appeal to this alone, rather than the introduction of the restored skeleton of Goldfuss, in which a fifth finger, so important in this discussion, is introduced, and its joints defined and numbered, not merely from imagination, but in obvious opposition to fact, no such finger having any existence in nature. Again, I may perhaps be allowed to remark, that in the figure of Draco volans, the fifth finger, which that singular animal undoubtedly possesses, has been accidentally omitted, a circumstance which serves to bring the five-fingered dragon a little nearer the four-fingered pterodactyle, just as the donation of the non-existent finger, to which I before alluded, seems to approximate the four-fingered pterodactyle to the five-fingered dragon. It would be trifling to notice little inaccuracies of this kind, did not the present position of Pterodactylus in the 'System of Nature' in some measure depend on them. I may also observe that Dr. Buckland has figured and numbered a very remarkable bone, particularly in Pterodactylus brevirostris, but I cannot find any reference to this in the description of the plate. This omission does not occur in the earlier works, but perhaps the definition of Goldfuss and others may not appear satisfactory: by whatever name this bone may be called it is very evidently the analogue of the marsupial bone.

One observation more. It is well known that there is a striated ap-

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pearance, closely resembling the impression of hair, observable on the stone in which the bones of these animals are found: indeed it was thus considered by the earlier writers on the subject, and from this circumstance, in combination with others, the remains were supposed to be those of mammals. The saurian hypothesis must, however, seek another explanation of the phenomenon, since a covering of hair is unknown amongst lizards. Agassiz, as quoted by Professor Buckland, therefore suggests that the striated surface of the stone was due to the impression of the minute foldings of the contracted membrane of the wings, but no sooner have our philosophers arrived at this conclusion, than a second difficulty appears to arise out of the first; how does it happen that the impression of so delicate and perishable a membrane as that of which the wings are composed should be thus beautifully preserved, while all trace of scales — those distinguishing features of lizards, and which in fishes defy the efforts of time — is utterly obliterated? Professor Buckland cuts the Gordian knot. "It is probable," says that eminent geologist, "that the pterodactyles had a naked skin, * * * because the weight of scales would have encumbered their movements in the air."* I am not aware whether this passage will strike my readers as it strikes myself, but the reasoning does not appear to me quite conclusive which uses the entire absence of scales as an argument in support of the hypothesis that the pterodactyles were lizards.

In conclusion, I must beg to repeat that these observations simply refer to the apparent incompleteness of the saurian hypothesis: I reserve for the pages of 'The Zoologist' my arguments in favour of another theory.

No. 7.

Page 54, line 13.—"*Uniformity and equal value.*"

I have long cherished, and frequently expressed an opinion, that all groups bearing similar titles should be precisely equivalent. At present

* Br. Tr. ii. 32, note.

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we find the greatest possible discrepancy between the value of groups which bear the same title. Even our great master in nomenclature, Linneus, in his zoological labours pays no regard whatever to this principle of uniformity. For instance, if we take his order Pecora in the placentals, Passeres in the birds, Coleoptera and Aptera in the insects, and carefully analyse their contents, and the characters by which they are distinguished, we shall find Aptera about sevenfold more comprehensive than Coleoptera, Coleoptera sevenfold more comprehensive than Passeres, and Passeres sevenfold more comprehensive than Pecora, so that the relative value of the orders Pecora and Aptera is about as one to three hundred and fifty; the bulk and commercial value of the Pecora being thus weighed against variety in structure and economy, and numerical preponderance. Most of our scientific entomologists have preserved these orders in all their discrepancy. All I desire is order and uniformity. In taking a statistical view of Britain we shall find it divided into counties, hundreds, parishes and houses; and, much as houses may vary in size, we never find any of them spoken of as hundreds or counties; neither are small counties ever alluded to as parishes or houses. It is the entire absence of this kind of precision that makes zoological grouping so vague and unsatisfactory; and until general opinion on this subject undergoes a complete change, the 'System of Nature' cannot be received: it must be regarded as a tablet engraven with hieroglyphics, the key to which is lost. It will be seen that in accordance with these views I give a similar title to the divisions of Pterota and Vertebrata, notwithstanding the immense mental, physical, and commercial superiority of the latter. I am aware that I cannot reasonably expect zoologists to take this view of the matter without considerable demur, still I consider the question one of such vital importance that I must be excused if I dwell on it somewhat more fully, and endeavour to test the supposed equality of the divisions of Pterota and Vertebrata, by selecting for a rapid analysis the best known in each, namely, Placentals and Coleoptera.

The divisions of placentals have been already defined with some care: they may be recapitulated thus.—

MANUPEDINA, equivalent to the Bimana, Quadrumana and Edentata tardigrada of Cuvier. Character scandent, or climbing and grasping animals whose feet are transmuted into hands; omnivorous, but mostly carpophagous or phyllophagous.

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Glirina, equivalent to the Glires of Linneus, including Lepus, Sciurus, Mus, Hystrix, &c. Character eminently saltant; fore-feet often used to hold food, but, in such instances, assuming the *office* without the *structure* of hands; almost entirely phytophagous, mostly carpophagous.

Vespertilionina, equivalent to the genus Vespertilio of Linneus, or the Cheiroptera of Cuvier. Character eminently volitant; fore-feet used for supporting, distending and moving a membranous wing; entomophagous, carpophagous, and said, in some instances, to suck the blood of men and animals.

Ferina, equivalent to the Feræ of Linneus, the Carnivora of other authors, including Canis, Felis, Viverra, Mustela, Ursus, Talpa, &c. Character rapacious, savage; mostly sarcophagous, a few entomophagous.

Cetina, equivalent to the Cete of Linneus, including Balæna, Delphis, Monodon, Manatus, Halicore, Trichecus, &c. Character natant, aquatic; possess no uniform character as to food.

Belluina, equivalent to the Belluæ and Pecora of Linneus, including Elephas, Rhinoceros, Hippopotamus, Sus, Camelus, Equus, Bos, &c. Character pachydermatous, ambulant, phyllophagous.

Brutina, equivalent to the Bruta of Linneus, including Glyptodon, Dasypus, Chlamyphorus, Manis, Myrmecophaga, Orycteropus, &c. Character repent, form elongate; entomophagous or phytophagous.

The divisions of Coleoptera, as proposed by myself in the 'Entomological Magazine' about ten years ago, and since republished in the 'Grammar of Entomology,' and still more recently in 'The Entomologist,' may be given as under: it should, however, be observed that the nomenclature is by no means satisfactory: other names are proposed in 'The Entomologist,' but I prefer using the original ones on the present occasion.

Scarabæina, equivalent to the Lamellicorns of recent authors, or the genus Scarabæus of early writers, including also Lucanus and Passalus, Aphodius and Trox, and apparently Byrrhus and Hister; concerning the last-named genera a doubt may be admitted. The normal groups of these beetles are very decidedly phytophagous, and it is only in the abnormal forms—for such I must consider Ateuchus, Copris, Phanæus — that we find them coprophagous. Their distinguishing characteristic is large size, slow gait, and inoffensive disposition; many of

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them are loaded with armature of horns, which appear rather designed for ornament than use.

Blapsina, equivalent to the Heteromera of authors, including the genera Pimelia, Blaps, Helops, Tenebrio, Mordella, Mylabris, &c. These are, generally speaking, slow, dark-coloured, nocturnal, and somewhat repulsive-looking beetles; they feed, for the most part, on decaying vegetable substances.

Buprestina, equivalent to the Serricornes and Malacodermes of the French, including Buprestis, Elater, Lampyris, Telephorus, Clerus, Ptinus: they differ generally from the preceding in having pentamerous tarsi: these are also phytophagous.

Cerambycina, equivalent to the Tetramera of recent authors: they possess a maggot-like larva, and include the great groups of Cerambyx, Curculio, Cucujus, and perhaps Donacia: these are strictly phytophagous.

Chrysomelina, equivalent to the Tetramera Cyclica of recent authors, including the groups Chrysomela, Cassida, Hispa, Erolytus, Eumorphus, and perhaps Coccinella: with the exception of the last group these are decidedly phyllophagous.

Silphina, equivalent to the Philhydrida and Necrophaga of recent authors, and including the groups Silpha, Dermestes, Nitidula, Hydrophilus, Helophorus, &c. These feed on animal and vegetable substances in a putrid state.

Carabina, equivalent to the Adephaga of recent authors, including the groups Cicindela, Carabus, Staphylinus and Dytiscus: these are strictly carnivorous.

It may possibly be objected that the divisions, both as regards placentals and beetles, are not those in common use; but to this I will reply that they accord with nature if not with usage, and I consider nature the higher authority. Some authors indeed may mix up the marsupials with the placentals, but I am confident this view of arrangement is perfectly untenable, and must be abandoned.

Now it must be observed that the tribes in the two series which I have just sketched are founded on precisely analogous, if not identical, characters. Both the classes comprise animals of the most diversified appetites, feeding on recent and putrid flesh, bone, insects, seeds, fruits, leaves, grass: the appetite is accompanied by the power and the structure essential to its gratification, and whether the food is found in the

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air, on trees, on the ground, or in the water, the quadruped and the beetle are alike gifted with the ability to seek it. If we pass from placentals to marsupials and birds, we shall find a similar diversity in food, and a similarly diversified mode of obtaining it.* If we proceed still another step, and compare the Carabina with the Ferina or Accipitrina, we shall find the analogy still holding good. The Dytiscites, the otters and the ospreys take their prey in the water; the Staphylinites, the hyænas and the vultures seek for flesh in a state of putrefaction; the Cicindelites, the hawks and the tigers prey only on living animals; the Carabites, foxes and owls prowl about by night: we shall find similar analogies existent in the most minute ramifications of all the groups. Indeed the study of Natural History is a study of degrees or grades of difference. The Vertebrata and Pterota are distinguished from each other by a broad and marked structural discrepancy: their organs of support, circulation and respiration, are formed on different plans. The divisions of Vertebrata and Pterota are distinguished by minor differences, principally by the varied development of the four or ten organs of locomotion with which they are respectively provided. The first difference is one of internal structure; the second is rather the adaptation of structure to diversified economy, as in placentals, birds, reptiles and fishes, or in butterflies, flies, bees and beetles. The subdivisions are distinguished by what might be called *sub-differences*. In birds and butterflies (Lepidoptera) these sub-differences occur chiefly in the mouth, legs and wings. By a little attention to these particulars equivalent divisions will be readily established, and universal order must result.

* It should here be remarked that marsupials, birds, both classes of reptiles, both classes of fishes, also Lepidoptera, Diptera, Hymenoptera, Orthoptera, Hémiptera and Neuroptera, divide in a similar manner, the primary divisions of the fourteen classes being exact equivalents.

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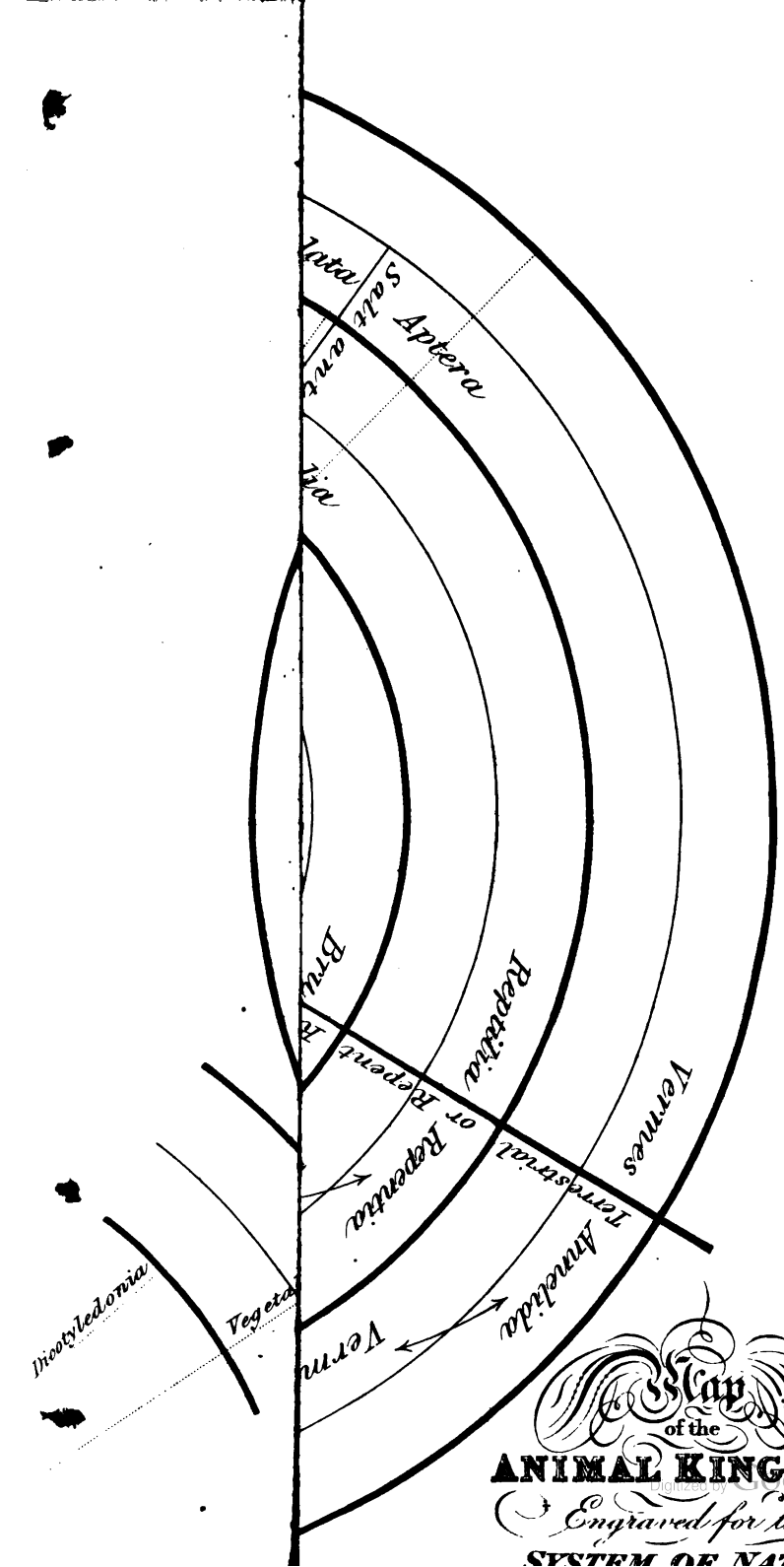

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